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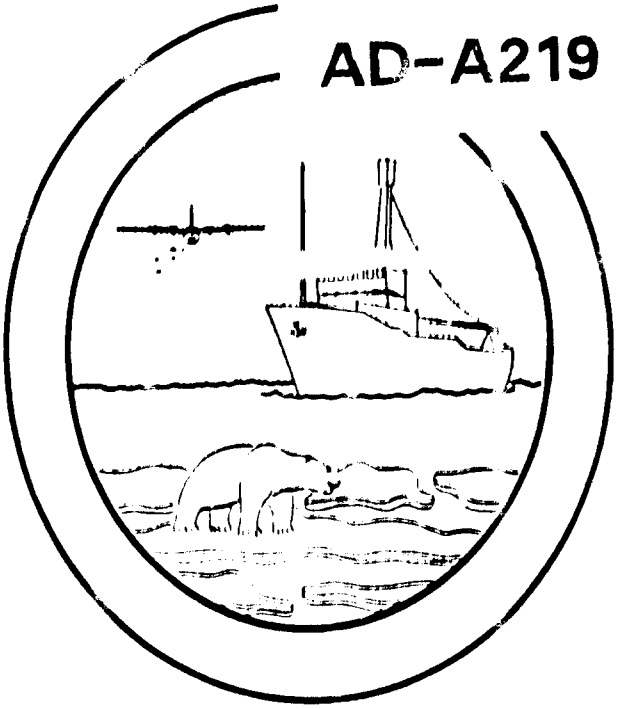
Informal Information Report

MIZEX 1987 SAR DATA SUMMARY



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MIZEX 1987 SAR DATA SUMMARY

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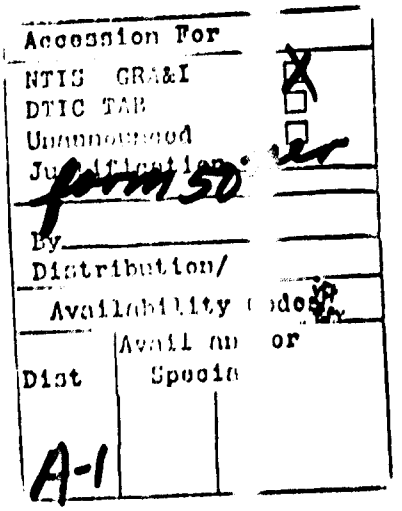

PREFACE

This report presents a summary of Synthetic Aperture Radar (SAR) data collected during the 1987 Marginal Ice Zone Experiment (MIZEX) by INTERA Technologies, Ltd. with scientific support from the Environmental Research Institute of Michigan (ERIM). ERIM scientists on board M/V POLAR CIRCLE as well as stationed at Svalbard planned and coordinated the INTERA STAR I and II SAR collection flights and performed real-time image analysis to facilitate sea truth and ship operations. The ERIM principal investigator was Dr. Robert Shuchman. He was assisted by Dr. Barbara Burns and Ms. Laura Sutherland. The INTERA activity covered under this contract included collection of SAR data, operation of the downlink on POLAR CIRCLE, generation of summary flight logs, mosaics of SAR imagery, and computer compatible tapes (CCT's). The INTRA principal investigator was Dr. Eric Leavitt. He was assisted by Messors Peter Button, Mathias Fruhwirth, Ralph Webster, Marvin Keyser, Dean Butler, Clay Atcheson, and Keith Tennant. The cooperative data collection effort was sponsored by the Office of Naval Research (ONR), INTERA contract no. N00014-87-C-0418, ERIM contract no. N00014-81-C-0195 under the technical guidance of Mr. Charles Luther.

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1.0 INTRODUCTION

The 1987 Winter MIZEX in the Greenland and Barents Seas, combined observation systems from both remote sensing and in situ data collection to provide an integrated approach to the study of winter Marginal Ice Zone (MIZ) conditions. Favorable weather permitted 18 consecutive days of SAR coverage and field operations. This was the first international experiment having daily SAR coverage with real-time imagery downlinked to the ships in the field. This real-time data proved to be a powerful and efficient tool to aid in the planning and carrying out of field experiments.

During MIZEX '87, two INTERA SAR equipped aircrafts; STAR-1 and STAR-2 were deployed to collect ice edge imagery. Throughout the experiment, real-time data was reviewed by ERIM scientists at Svalbard and on board the M/V POLAR CIRCLE. Observations made from this imagery enabled them to select areas of special interest for intensive study and sea truthing, and to plan successive SAR missions. A total of 24 missions were flown. Mission 1 was completed while STAR-1 was en route from Iceland to Svalbard. Missions 2-18 and 22 were collected over the Greenland Sea and missions 19-21 were collected over the Barents Sea. Two additional missions, ND-1 and ND-2 were flown coincident to Geosat tracks over the Greenland Sea in support of the Naval Ocean Research Development Activity (NORDA). A summary of all missions is included in Table 1.

Keywords: MIZEX, Marginal Ice Zone Experiment, MIZ, Marginal Ice Zone, SAR, Synthetic Aperture Radar, Sea Truthing, M/V POLAR CIRCLE,

The STAR-1 and STAR-2 systems provided a number of SAR image and tape products in real-time. The SAR data was processed into image data while collected. This image data was written onto High Density Digital Tapes (HDDT's) on the airplane as well converted into a paper image at a scale of 1:300,000. Both of these products represented the full resolution capability and quality of the system. Real-time SAR data was also downlinked to the M/V POLAR CIRCLE to aid in both sea truthing and ship navigation. The data transmitted to the ship was

Greenland Sea, Barents Sea, Remote Sensing, Polar Exploration, ICE EDGE IMAGERY, High Density Digital Tapes, HDDT, Ship Navigation.

[TG]

TABLE 1. MISSION SUMMARY. The start and end times refer to data collection, rather than take-off and landing times.

MISSION NO.	AIRCRAFT	LOCATION	DD/MM	START TIME (GMT)	TIME	FLIGHTLINES
1	STAR-1	Greenland Sea	27/03	17:25	21:23	4
2	STAR-1	Greenland Sea	28/03	02:21	04:21	3
3	STAR-1	Greenland Sea	28/03	20:51	01:19	5
4	STAR-1	Greenland Sea	30/03	08:21	12:30	6
5	STAR-1	Greenland Sea	31/03	13:41	17:04	5
6	STAR-1	Greenland Sea	31/03	22:11	01:58	5
7	STAR-1	Greenland Sea	01/04	16:19	19:14	5
8	STAR-2	Greenland Sea	02/04	10:44	13:50	4
9	STAR-2	Greenland Sea	02/04	16:39	19:40	5
10	STAR-2	Greenland Sea	03/04	09:38	13:00	4
11	STAR-2	Greenland Sea	03/04	17:19	20:30	3
12	STAR-2	Greenland Sea	04/04	17:57	21:43	4
13	STAR-2	Greenland Sea	05/04	09:18	12:47	4
14	STAR-2	Greenland Sea	05/04	17:41	21:00	5
15	STAR-2	Greenland Sea	06/04	12:29	15:29	5
16	STAR-2	Greenland Sea	07/04	11:08	14:20	4
17	STAR-2	Greenland Sea	07/04	18:30	20:32	3
18	STAR-2	Greenland Sea	08/04	13:28	17:01	4
19	STAR-2	Barents Sea	09/04	12:22	16:12	4
20	STAR-2	Barents Sea	10/04	09:10	13:30	4
21	STAR-2	Barents Sea	11/04	09:02	12:57	5
22	STAR-2	Greenland Sea	12/04	11:53	12:57	2
ND-1	STAR-2	Greenland Sea	13/04	06:21	08:54	3
ND-2	STAR-2	Greenland Sea	14/04	09:18	11:56	1

additionally converted to a lesser quality film product as well as written onto computer compatible tapes (CCT's). The resolution of the ship produced CCT's was reduced to 12 x 12 meters from STAR-1 and 16 x 16 meters from STAR-2. This decrease in resolution represents a slight image degradation.

Unfortunately, due to HDDT airborne recorder failure the CCT's produced on the ship represent the only digital data for missions 1-7. However, initial analysis of the real-time data indicates that all the science objectives of the experiment can still be realized. Other missions have CCT's of full resolution produced from the aircraft HDDT's.

Supporting the initial interpretation of the SAR signature are a variety of the in situ measurements and observations. These include intensive ice sampling, drifting argos buoys, current meter measurements, wave riders, pitch and roll buoys, and ice flow accelerometers. Preliminary analysis indicates the following:

1. SAR imagery permits differentiation between first year ice, multi-year ice, and many stages of young ice;
2. SAR imagery can be used to detect surface expressions of eddies both in the open ocean and within the ice pack;
3. SAR imagery permits the tracking of ocean waves both outside and propagating approximately 100 km into the ice pack;
4. SAR imagery shows internal wave features beneath the ice pack; and,
5. SAR imagery mapped an ocean polar front in the Barents Sea.

The remainder of this report contains a description of the STAR system, an overview of the STAR operations during MIZEX, and a data description and analysis summary. Included in the summary are detailed listings of flight line and data recording information for each of the flights and maps showing areas of coverage. Real-time imagery mosaics for missions 2-9 and 11-21 as well as the results of

manual geophysical extractions such as ice edge location, and flow size and concentration interpretations are presented. Appendix A contains a log of CCT's for all missions.

2.0 SYSTEM DESCRIPTION

During MIZEX '87 real-time imagery was downlinked to the ships in the field. The following is a description of the STAR systems used to collect the data and the downlink system used to view and archive the real-time data on POLAR CIRCLE.

2.1 THE STAR SYSTEMS

The STAR systems, STAR-1 and STAR-2, are both X-band SAR systems. The basic specifications for the two systems are Given in Table 2. Viewing geometries for the two systems in wide swath modes are shown in Figure 1 and Figure 2. The important differences between the two systems are swath width and resolution. The STAR-2 system operates at slightly lower resolution than STAR-1 in return for 30% greater swath width in wide swath mode and thus potentially 30% greater coverage during a mission.

The STAR's are each mounted in Cessna Conquests and are capable of mapping a continuous swath on either side of the aircraft. Both narrow and wide swath modes were utilized during MIZEX. Digital processing of the signal is done in real-time and recorded in digital form onboard the aircraft using a high density data recorder for later processing. (Approximately 1 giga byte of data can be collected during one mission.) The imagery is also displayed onboard using a high resolution recorder and heat processed paper. This product can be used to identify features and make decisions about mission profiles in flight or it can be used by clients immediately following a flight to determine ice conditions. During MIZEX, the hardcopy output from the aircraft was used in Svalbard to monitor ice conditions and plan missions.

2.2 DOWNLINK SYSTEM

The downlink system accepts the digital data and formats it to a form suitable for transmission in real time to receiver stations. The

TABLE 2. STAR SPECIFICATIONS AS USED IN MIZEX

PROPERTY	STAR-2	STAR-1
Operating Altitude	29,000 ft.	
Wave length	X-band	
Polarization	HH	
Viewing Direction	Left or Right	
Processing	Real time	
Recording	8 bit data, full bandwidth data recording on parallel HDDR	4 bit data, either 12 x 12m or 24 x 24m pixels on serial HDDR
Swath width		
Narrow (Hi-Res)	17 km	23 km
Wide (Lo-Res)	63 km	45 km
Pixel size	Along track/ cross track	Along track/ cross track
Hi-Res	4 x 4 m	Not used
Lo-Res	5.2 x 16m	12 x 12m or 24 x 24m
Downlink	4 bits	4 bits
Azimuth Looks	7	7
Lo-Res	16 x 16m or 32 x 32m	12 x 12m or 24 x 24m

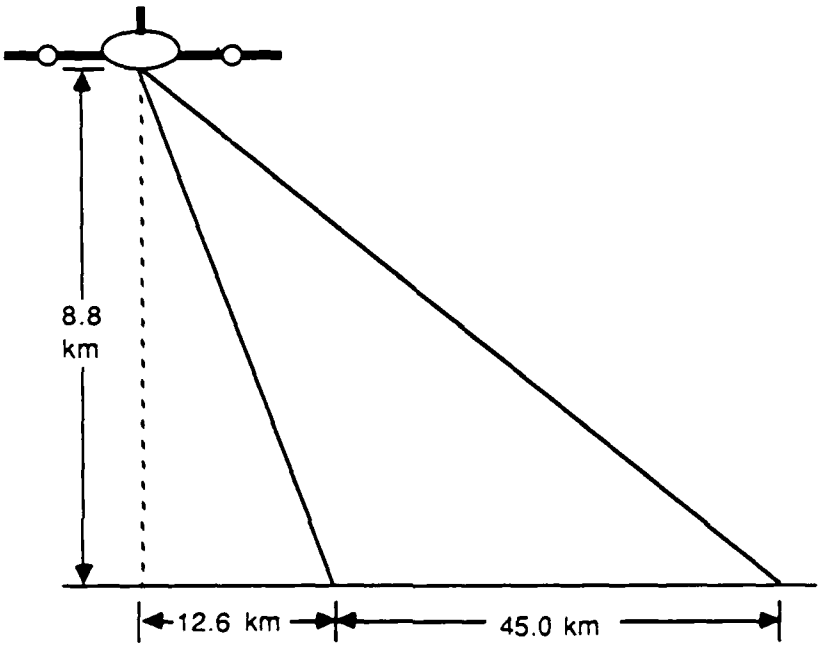


Figure 1. Viewing Geometry for Star-1 in Wide Swath Mode

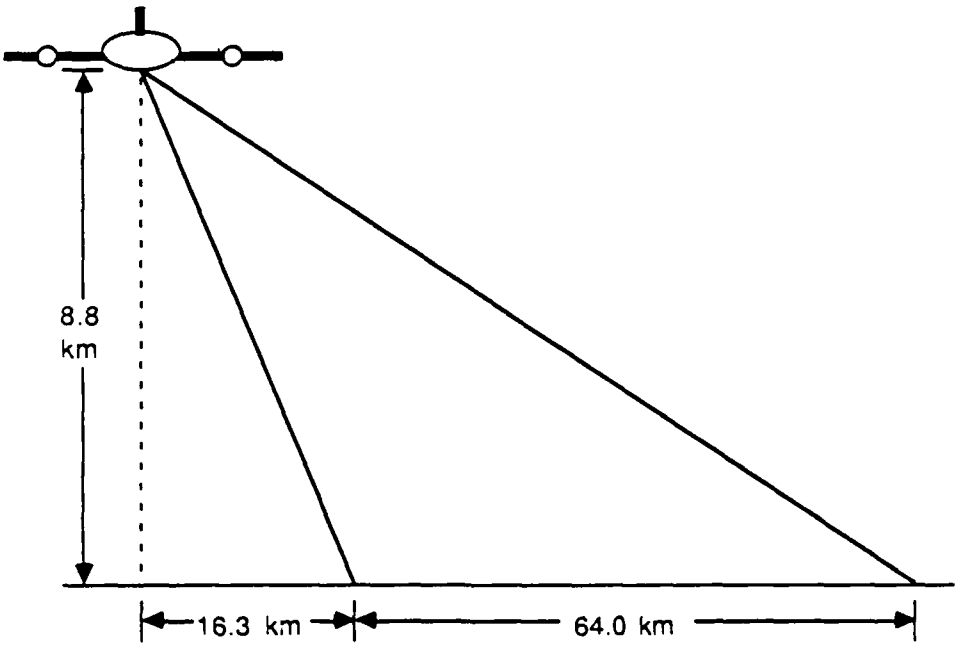


Figure 2. Viewing Geometry for Star-2 in Wide Swath Mode

data are reduced to 4 bits per pixel with a line size of 4096 or 6048 pixels. The pixel sizes in both modes are listed in Table 2 for the two STAR systems.

After reduction to 4 bit square pixels, the data is suitable for transmission on a 280 kbit/sec downlink. The data are first converted from parallel to serial form and a start code is introduced at the beginning of each line. The data are then "pseudo-scrambled" to insure adequate data repetitions are sent to the transmitter for modulation on the carrier frequency of 219.5 Mhz. The resultant signal is broadcast on an antenna with a near isotropic pattern. The range of the downlink during MIZEX was typically 200 nm.

2.3 STAR-VUE DOWNLINK

During MIZEX a STAR-VUE downlink system was mounted on the POLAR CIRCLE.

The STAR-VUE hardware which was included on the POLAR CIRCLE included:

1. host 11/73 processor;
2. receiver subsystem;
3. monitor with video memory;
4. trackball interface;
5. sufficient memory to store 4-6 hours of flying;
6. tape drive for storing information on CCT;
7. hardcopy interface; and
8. hardcopy VISOR unit.

STAR-VUE can be programmed to receive data from the STAR downlink, transfer the data to a disk file, and enter that file into the geo-referenced data base. The flightline parameters are entered manually by the user and flight lines can then be accessed by the user via a map presentation on the screen. The files on disk are given an 'icon'

on that map that shows their location (in latitude/longitude). The user selects the file to be displayed via a cursor/trackball system.

Once the desired flight line (file) is selected, the user can choose to display the data in the file on a dual resolution screen. One small display presents an overview of the data in the flight line file. A larger display shows a portion of the data on the left window, at a user selectable zoom. Data is selected via a cursor box on the overview display which is roamed and zoomed under user control.

At any time during data reception, the user can select a waterfall display of the incoming data stream. However, if it is not essential to view incoming data, the user can continue with normal use of STARVUE for ice navigation, with only a slight loss of responsiveness on the system.

During downlinking on the POLAR CIRCLE, a hard copy of the incoming imagery was generated on the VISOR hardcopy unit. Additional hardcopy products were generated after completion of a flight at about 2X real time.

3.0 OVERVIEW OF STAR OPERATIONS DURING MIZEX 87

Operations are described in terms of airborne operations and STAR-VUE operations. A brief summary of how real-time SAR data was utilized for oceanographic and navigation purposes is also included.

3.1 AIRBORNE OPERATIONS CHRONOLOGY

The original schedule called for STAR-2 to arrive in Iceland on March 23 to fly two flights jointly with NASA along Geosat tracks north and west of Iceland.

STAR-2 was then to transit to Svalbard, performing a downlink mission over the Odden area on March 26. Once-daily flights were then to be carried out in the Greenland and Barents Seas until April 11.

Due to mechanical problems with the STAR-2 aircraft the initial deployment to Iceland had to be abandoned. STAR-1 was substituted for STAR-2 and arrived in Iceland March 26. While en route to Svalbard the first data was downlinked to the POLAR CIRCLE on March 27 at 1800. A second flight was conducted at 0200 GMT March 28 to provide the first full mosaic of the study area in the Greenland Sea.

Operations with STAR-1 continued through April 2, mission 7. Due to HDDT recorder failure, the CCT's produced on the ship represent the only digital data for these missions. On April 2, STAR-2 arrived in Svalbard and flew the remaining 17 missions. Operations in the Greenland Sea continued until April 8. During this period some difficulties were encountered with the STAR-2 tape drive on April 3 and 6. Data for these flights were archived on STAR-VUE so no data was lost. Other missions have CCT's of full resolution produced from the aircraft HDDT's.

On April 9, 10, and 11, STAR-2 conducted three missions over the southern Barents Sea. On April 12, STAR-2 deployed to Iceland where

two missions were flown on April 13 and 14 along Geosat tracks. STAR-2 then returned to Calgary. The total number of missions was 24.

STAR-1 and STAR-2 collect data in a continuous swath looking left or right along the aircraft track. Typical MIZEX missions consisted of a series of north-south overlapping lines from the ice edge inward. In addition to these standard mosaic lines additional lines were laid out to cover areas of special interest, including high-resolution lines for remote sensing studies.

3.2 STAR-VUE OPERATIONS CHRONOLOGY

The STAR-VUE downlink was installed on the POLAR CIRCLE and tested in Tromso prior to departure. Testing included receiving a test transmission over the complete downlink antenna and cable arrangement. The STAR-VUE receiver was installed in the remote sensing hut on the base deck of the POLAR CIRCLE. The antenna was placed atop the crow's nest next to the INMARSAT receiver.

As mentioned above, the first downlink reception occurred on the evening of March 26. Following some initial problems with receiving STAR-1 data, as opposed to the expected STAR-2 data, reception was provided without major difficulties.

Unfortunately, the VISOR hardcopy unit output proved to be of marginal acceptability. This unit had been substituted for an EDO unit. Apparently the vibration experienced in the shipboard environment, as opposed to the aircraft where it is normally used, or in the laboratory where it was tested prior to the voyage, affected the focussing of the laser beam resulting in very poor image contrast.

Operator experience with the unit caused the hardcopy quality to improve but it remained only acceptable. The hardcopy, however, proved to be useful for planning oceanographic measurements and for locating ice features for the remote sensing program. There was also

the option of receiving the imagery on the video screen, although this was not utilized as much as expected prior to the voyage.

After STAR-2's arrival, operation of the STAR-VUE became somewhat more routine. Only very minor problems were encountered until April 8 when reception failed. The failure occurred when a connector between the antenna and the pre-amplifier came apart. The unit was made functional halfway through the mission.

STAR-VUE data storage capability proved useful when the STAR-2 aircraft recorder experienced several failures. This occurred during three mission flights (two partial and one complete-mission). The data was received and successfully archived using STAR-VUE, so no significant amount of information was lost due to this tape recorder problem.

3.3 DATA UTILIZATION DURING MIZEX

The radio downlinked SAR imagery provided data directly to the field investigators. This real-time imagery was used to plan the ship and helicopter tracks, and to choose areas of special interest for intensive study and sea truthing.

3.3.1 Oceanography

The use of the SAR imagery to support the oceanographic program objective of studying eddies was perhaps the most exciting aspect of the cruise.

SAR imagery was used to locate several eddies and to guide the POLAR CIRCLE and HAKON MOSBY to the appropriate locations to conduct CTD surveys, etc. In one case, the POLAR CIRCLE traversed through the center of an eddy located using the SAR imagery. Successive images enabled observation of eddies as they progressed through various stages of development.

The ice edge location was abstracted from the completed mosaics and transmitted to the HAKON MOSBY where it was used as an input to their sampling program.

The first imagery of the Barents Sea (on April 9) was downlinked while the POLAR CIRCLE was enroute. This imagery was used to choose the location of the study area for the brief Barents Sea visit.

Several experiments were run to test the ability of the x-band SAR to sample the ocean wave regime. This was successful, and in particular, an ocean front south of Bear Island was observed in the imagery. The position of the front was verified by CTD and thermister chain sampling on April 11.

3.3.2 Navigation

Due to ice conditions, the imagery was used only sporadically in navigating the ship. The use of SAR imagery for arctic navigation could be greatly improved if the STAR-VUE display was located in the bridge during future expeditions.

4.0 DATA DESCRIPTION AND ANALYSIS

A total of 24 SAR missions were flown during the '87 winter MIZEX. Details of flight and SAR parameters for all missions are given in Tables 3-27 including:

1. mission numbers;
2. date of mission;
3. flightline identifier (listed as flown);
4. aircraft parameters; and,
5. STAR-system SAR parameters.

Figure 3 shows the location map for mission 1 which was completed while STAR-1 was en route from Iceland to Svalbard. Due to the extensive area of coverage and lack of overlap between passes imagery for mission 1 is not included in this report.

Data for missions 2-9 were collected over the Greenland Sea. Figures 4-35 are location maps, real-time imagery mosaics of wide swath passes, ice edge locations, and preliminary ice concentration and floe size interpretations for these missions.

Figure 36 shows the area of coverage for mission 10. This mission consisted of 1 wide and 3 narrow swath passes over the Greenland Sea. Data from this mission will be used for σ_0 analysis.

Mission 11-18 were also flown over the Greenland Sea. Data for missions 16 and 17 were collected less than five hours apart. Due to the close proximity of time and area covered for these two missions data was mosaicked together and interpreted as one mission. Real-time imagery mosaics of wide swath passes, ice edge locations and preliminary ice concentration and floe size interpretations are presented in Figures 37-64.

Ice and ocean data from the southern Barents Sea were collected during missions 19-21. Location maps, real-time imagery mosaics, ice

edge location, and preliminary ice concentration and floe size interpretations are presented in Figures 65-76.

Mission 22 took place during STAR-2's transit back to Iceland for the NORDA collection. Figure 77 is the location map for this mission.

Two missions, ND-1 and ND-2 were then flown coincident to Geosat tracks. Areas of coverage for both these mission are presented in Figure 78. STAR-2 then returned to Calgary.

TABLE 3
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 1, 27 March 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
1	38°	291.5	29000	17:25	18:53	66°00'N	20°50'W	71°28'N	08°30'W
2	15.5°	288	29000	19:03	20:05	72°30'N	08°20'W	77°00'N	03°00'W
3	360°	274.5	29000	20:10	20:38	77°20'N	02°59'W	79°20'N	03°00'W
4	81°	299	29000	20:41	21:23	79°20'N	02°50'W	79°20'N	14°00'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
1	R	18	10°	Wide Swath	1/2
2	R	18	10°	Wide Swath	1/2
3	R	18	10°	Wide Swath	1/2
4	R	18	10°	Wide Swath	1/2

TABLE 4
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 2, 28 March 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
1	180°	276	31000	02:21	02:43	79°30'N	03°00'E	77°30'N	03°00'E
2	360°	258.5	31000	02:51	03:19	77°30'N	01°00'E	79°30'N	01°00'E
3	180°	274.5	31000	03:38	03:53	79°30'N	01°00'W	77°30'N	01°00'W
4	360°	262	31000	04:07	04:21	77°30'N	01°00'E	78°47'N	01°00'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
1	R	19	10°	Wide Swath	1/2
2	L	19	10°	Wide Swath	1/2
3	R	19	10°	Wide Swath	1/2
4	L	19	10°	Wide Swath	1/2

TABLE 6
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 3, 28/29 March 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
1	282°	264.5	31000	20:51	21:18	78°44'N	07°50'E	79°04'N	03°10'W
2	212°	267.5	31000	22:00	22:45	79°39'N	09°00'E	78°51'N	01°39'E
3	25°	275.5	31000	22:53	23:35	76°56'N	00°19'E	79°48'N	08°01'E
4	210°	265	31000	23:47	00:30	79°48'N	08°31'E	78°50'N	01°23'W
5	25°	286	31000	00:40	01:19	77°00'N	02°38'W	79°48'N	05°01'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
1	L	19	13°	Narrow Swath	1/2
2	R	19	13°	Wide Swath	1/2
3	L	19	13°	Wide Swath	1/2
4	R	19	13°	Wide Swath	1/2
5	L	19	9.9°	Wide Swath	1/2

TABLE 6
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 4, 30 March 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	275°	268	31000	08:21	08:41	79°50'N	05°00'E	79°50'N	03°30'W
B	180°	264	31000	08:50	09:30	79°52'N	04°59'W	77°00'N	05°00'W
C	360°	274.5	31000	09:39	10:19	77°00'N	03°12'W	80°00'N	03°12'W
D	180°	278	31000	10:33	11:14	80°00'N	01°24'W	77°00'N	01°24'W
E	360°	280.5	31000	11:24	12:02	77°02'N	00°38'E	80°00'N	00°38'E
F	88°	272	31000	12:18	12:30	79°25'N	00°30'W	79°25'N	05°00'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	19	9.9°	Wide Swath	1/2
B	R	19	9.9°	Wide Swath	1/2
C	L	19	9.9°	Wide Swath	1/2
D	R	19	9.9°	Wide Swath	1/2
E	L	19	9.9°	Wide Swath	1/2
F	R	19	9.9°	Wide Swath	1/2

TABLE 7
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 5, 31 March 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	270°	249	31000	13:41	14:04	78°30'N	01°55'E	78°30'N	08°00'W
B	14°	277.5	31000	14:22	14:44	78°20'N	03°00'W	79°55'N	00°40'W
C	201°	242.5	31000	14:54	15:42	79°55'N	01°30'E	78°50'N	03°40'W
D	19°	291	31000	15:52	16:32	78°50'N	02°00'W	79°55'N	03°40'E
E	203°	261	31000	16:41	17:04	79°50'N	05°37'E	78°16'N	02°20'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	19	13°	Narrow Swath	1/2
B	L	19	9.9°	Wide Swath	1/2
C	R	19	9.9°	Wide Swath	1/2
D	L	19	9.9°	Wide Swath	1/2
E	R	19	9.9°	Wide Swath	1/2

TABLE 8
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 6, 31 March/1 April 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	270°	244	31000	22:11	22:38	79°48'N	05°00'E	79°48'N	08°00'W
B	180°	247	31000	22:48	23:31	79°55'N	05°00'W	77°00'N	05°00'W
C	360°	291	31000	23:39	00:16	77°04'N	03°12'W	80°00'N	03°12'W
D	180°	250.5	31000	00:29	01:13	80°00'N	01°24'W	77°00'N	01°24'W
E	360°	248	31000	01:22	01:58	77°00'N	00°36'E	80°00'N	00°36'E

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	19	9.9°	Wide Swath	1/2
B	R	19	9.9°	Wide Swath	1/2
C	L	19	9.9°	Wide Swath	1/2
D	R	19	9.9°	Wide Swath	1/2
E	L	19	9.9°	Wide Swath	1/2

TABLE 9
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 7, 1 April 1987)

STAR 1 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	185°	245	31000	16:19	16:40	79°59'N	04°19'E	78°30'N	03°40'E
B	2°	291	31000	16:51	17:10	78°30'N	01°50'E	80°00'N	02°10'E
C	180°	255	29000	17:21	18:14	80°00'N	00°00'	77°00'N	00°00'
D	360°	294	29000	18:25	18:46	77°00'N	01°40'W	78°30'N	01°40'W
G	91°	258	29000	19:01	19:14	78°20'N	05°00'W	78°20'N	00°00'

STAR 1 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	19	9.9°	Wide Swath	1/2
B	L	19	9.9°	Wide Swath	1/2
C	R	18	9.9°	Wide Swath	1/2
D	L	18	9.9°	Wide Swath	1/2
G	R	18	9.9°	Narrow Swath	1/2

TABLE 10
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 8, 2 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	268°	235	29000	10:44	11:13	80°10'N	05°00'E	80°10'N	08°00'W
B	180°	246	29000	11:22	12:10	79°40'N	05°15'W	77°00'N	05°15'W
C	360°	278	29000	12:17	12:58	77°00'N	03°50'W	79°50'N	03°50'W
D	180°	254	29000	13:05	13:50	79°50'N	01°25'W	77°00'N	01°25'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	15.3	7.4°	Wide Swath	1
B	R	15	7.4°	Wide Swath	1
C	L	15	7.4°	Wide Swath	1
D	R	15.4	7.4°	Wide Swath	1

TABLE 11
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 9, 2 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	270°	246	29000	16:39	16:53	79°40'N	05°00'E	79°40'N	00°00'
C	180°	238	29000	17:05	17:49	79°50'N	01°25'E	77°00'N	01°25'E
B	360°	284	29000	18:01	18:41	77°00'N	01°00'W	80°00'N	01°00'W
D	180°		29000	19:06	19:23	79°30'N	03°25'W	78°20'N	03°25'W
E	360	266	29000	19:30	19:40	78°20'N	05°06'W	79°29'N	05°06'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	15	9.5°	Wide Swath	1/2
C	R	15	9.5°	Wide Swath	1/2
B	L	15.4	9.5°	Wide Swath	1/2
D	R	15.4	9.5°	Wide Swath	1/2
E	L	15.4	9.5°	Wide Swath	50

TABLE 12
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 10, 3 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	210°	217	29000	09:38	10:18	79°10'N	00°00'	77°19'N	04°00'W
B	44°	300	29000	11:28	11:42	77°25'N	06°45'W	78°15'N	02°50'W
D	270°	297	29000	11:58	12:15	77°33'N	03°00'W	77°33'N	07°00'W
C	90°	294	29000	12:23	13:00	77°25'N	07°00'W	77°25'N	03°00'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.4	05.6°	Wide Swath	1/2
B	R	10	18°	Narrow Swath	40
D	R	10	17.4°	Narrow Swath	42
C	L	10	16.4°	Narrow Swath	38

TABLE 13
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 11, 3 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
B	360°	-	31000	17:19	-	76°30'N	03°50'W	80°00'N	03°50'W
C	180°	236	31000	18:18	19:09	80°00'N	01°25'W	76°30'N	01°25'W
D	360°	269	31000	19:22	19:58	76°30'N	01°00'E	80°00'N	01°00'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
B	L	16.5	7.8°	Wide Swath	43
C	R	16.5	7.8°	Wide Swath	43
D	L	16	7.8°	Wide Swath	44

TABLE 14
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 12, 4 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	273°	250	29000	17:57	18:21	80°00'N	05°00'E	80°00'N	04°00'W
B	180°	268	29000	18:30	19:25	80°00'N	04°01'W	76°00'N	04°01'W
C	360°	235	29000	19:35	20:38	76°02'N	01°35'W	80°00'N	01°35'W
D	180°	269	29000	20:48	21:43	80°00'N	00°50'E	76°29'N	00°50'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	15.5	8.5°	Wide Swath	48
B	R	15.4	8.5°	Wide Swath	43
C	L	15.4	8.5°	Wide Swath	43
D	R	15.5	8.5°	Wide Swath	43

TABLE 15
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 13, 5 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	276°	215	29000	09:18	10:15	75°53'N	04°00'E	75°51'N	08°04'W
B	339°	176	29000	10:44	11:28	76°30'N	04°30'W	79°00'N	09°30'W
C	156°	215	29000	11:44	12:15	79°00'N	07°00'W	76°30'N	02°00'W
D	339°	275	29000	12:28	12:47	76°30'N	00°30'E	77°30'N	01°20'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.5	10°	Wide Swath	60
B	L	15.5	10°	Wide Swath	44
C	R	15.4	10°	Wide Swath	44
D	L	15.4	10°	Wide Swath	44

TABLE 16
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 14, 5 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	277°	247	29000	17:41	18:11	79°02'N	04°00'E	79°03'N	10°00'W
B	157°	260	29000	18:33	19:12	79°12'N	12°11'W	76°30'N	07°00'W
C	336°	247	29000	19:29	19:46	76°30'N	04°30'W	77°30'N	06°30'W
D	154°	278	29000	19:57	20:08	77°30'N	04°00'W	76°30'N	02°00'W
E	340°	249	29000	20:25	21:00	76°30'N	00°30'E	79°00'N	04°30'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.3	8.4°	Wide Swath	56
B	R	15.3	8.4°	Wide Swath	44
C	L	15.3	8.4°	Wide Swath	44
D	R	15.3	8.4°	Wide Swath	44
E	L	15.3	8.4°	Wide Swath	44

TABLE 17
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 15, 6 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	195°	245	31000	12:29	13:00	79°00'N	01°30'E	76°30'N	01°30'W
B	270°	238	31000	13:22	-	76°20'N	03°15'W	76°20'N	06°00'W
C	89°	244	31000	13:55	14:03	76°40'N	07°30'W	76°40'N	02°00'W
D-1	-	-	31000	-	-	76°30'N	03°00'W	76°29'N	04°30'W
D-2	270°	250	31000	-	-	76°30'N	04°30'W	76°30'N	07°00'W
E	13°	250	31000	14:50	15:29	76°30'N	03°59'W	79°00'N	01°00'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	16.4	8.8°	Wide Swath	1/2
B	R	16.4	8.8°	Wide Swath	1/2
C	R	10	8.8°	Narrow Swath	1/2
D-1	R	10	8.8°	Narrow Swath	39
D-2	L	10	8.8°	Narrow Swath	44
E	L	16.4	8.8°	Wide Swath	44

TABLE 18
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 16, 7 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	273°	228	29000	11:08	11:30	76°42'N	00°00'	76°42'N	08°00'W
B	360°	237	29000	11:58	12:36	76°01'N	06°31'W	79°15'N	06°30'W
C	180°	243	29000	13:00	13:39	79°15'N	04°00'W	76°00'N	04°00'W
D	87°	284	29000	14:01	14:20	75°59'N	04°30'E	75°49'N	02°03'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	10	18.4°	Narrow Swath	36
B	L	15.4	8.4°	Wide Swath	44
C	R	15.4	8.4°	Wide Swath	44
D	L	15.4	8.4°	Wide Swath	44

TABLE 19
SUMMARY OF STAR-2 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 17, 7 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
E	272°	234	31000	18:30	18:44	79°25'N	05°00'E	79°25'N	01°00'W
F	180°	273	31000	18:52	19:34	79°13'N	02°06'W	76°00'N	02°06'W
G	360°	210	31000	19:55	20:32	76°00'N	00°04'E	78°02'N	00°04'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
E	L	16.4	8.8°	Wide Swath	56
F	R	16.4	8.8°	Wide Swath	44
G	L	16.4	8.8°	Wide Swath	44

TABLE 20
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 18, 8 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	275°	188	29000	13:28	14:19	75°52'N	06°00'E	75°54'N	06°02'W
B	360°	245	29000	14:35	15:20	78°00'N	04°10'W	79°15'N	04°11'W
C	179°	267	29000	15:30	16:08	79°15'N	02°00'W	78°00'N	02°00'W
D	360°	237	29000	16:26	17:07	78°00'N	00°10'E	78°14'N	00°10'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	15.4	8.4°	Wide Swath	56
B	L	15.4	8.4°	Wide Swath	56
C	R	15.4	8.4°	Wide Swath	44
D	L	15.4	8.4°	Wide Swath	44

TABLE 21
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 19, 9 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	162°	297	29000	12:22	13:07	77°44'N	08°30'E	74°15'N	14°20'E
B	342°	209	29000	13:20	14:12	74°15'N	16°25'E	77°00'N	12°15'E
C	162°	312	29000	14:20	14:50	76°45'N	15°00'E	74°14'N	18°30'E
D	342°	200	29000	15:13	16:12	74°15'N	20°38'E	77°40'N	16°15'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	L	15.2	8.4°	Wide Swath	44
B	R	15.2	8.4°	Wide Swath	60
C	L	15.2	8.4°	Wide Swath	44
D	R	15.2	8.4°	Wide Swath	44

TABLE 22
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 20, 10 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	187°	290	29000	09:10	09:55	77°00'N	21°15'E	73°30'N	21°16'E
B	360°	195	29000	10:13	11:10	73°30'N	19°30'E	77°00'N	19°31'E
C	180°	308	29000	11:25	11:59	77°00'N	17°46'E	73°30'N	17°46'E
D	360°	216	29000	12:18	13:11	73°30'N	16°00'E	77°00'N	16°01'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.4	8.4°	Wide Swath	44
B	L	15.4	8.4°	Wide Swath	57
C	R	15.4	8.4°	Wide Swath	44
D	L	15.4	8.4°	Wide Swath	57

TABLE 23
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 21, 11 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
B	180°	273	29000	09:02	09:49	77°00'N	19°30'E	73°30'E	19°30'E
E	360°	247	29000	10:00	10:50	73°30'N	19°38'E	77°00'N	19°45'E
C	180°	270	29000	11:10	11:57	77°00'N	17°46'E	73°30'N	17°40'E
D	360°	263	29000	12:08	12:57	73°30'N	18°01'E	77°00'N	16°01'E

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
B	R	15.3	8.4°	Wide Swath	44
E	L	15.3	19.9°	Wide Swath	57
C	R	15.4	10.4°	Wide Swath	44
D	L	15.4	8.4°	Wide Swath	57

TABLE 24
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION 22, 12 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
1	180°	266	29000	11:53	12:20	77°53'N	00°01'W	78°00'N	00°01'W
2	221°	248	29000	12:27	12:47	76°42'N	00°04'W	74°00'N	03°00'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
1	R	15.4	10.4°	Wide Swath	57
2	R	15.4	8.4°	Wide Swath	44

TABLE 25
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION ND-1, 13 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	273°	275	29000	06:50	07:13	71°29'N	19°00'W	71°31'N	23°00'W
B	180°	200	29000	07:31	08:07	72°00'N	22°39'W	70°00'N	22°39'W
C	115.5°	205	29000	08:24	08:54	70°22'N	25°00'W	69°34'N	20°28'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.4	10.4°	Wide Swath	50
B	L	15.4	10.4°	Wide Swath	50
C	L	15.4	10.4°	Wide Swath	1/4

TABLE 26
SUMMARY OF STAR-1 SAR AND AIRCRAFT PARAMETERS
DURING MIZEX-87
(MISSION ND-2, 14 April 1987)

STAR 2 AIRCRAFT PARAMETERS

PASS NO	HEADING (TRUE)	AVERAGE VELOCITY (KNOTS)	ALTITUDE (FEET)	START-TIME (GMT)	STOP-TIME (GMT)	START LATITUDE	START LONGITUDE	STOP LATITUDE	STOP LONGITUDE
A	280°	270	29000	06:21	06:53	71°11'N	11°00'W	71°29'N	18°30'W
D	240°	218	29000	09:18	11:51	68°30'N	22°24'W	62°21'N	41°00'W

STAR 2 SAR PARAMETERS

PASS NO	LOOK DIRECTION	SLANT RANGE DELAY (Km)	ANTENNA ELEVATION	MODE	REAL-TIME PROCESSOR GAIN
A	R	15.4	10.4°	Wide Swath	50
D	R	15.4	8.4°	Wide Swath	50

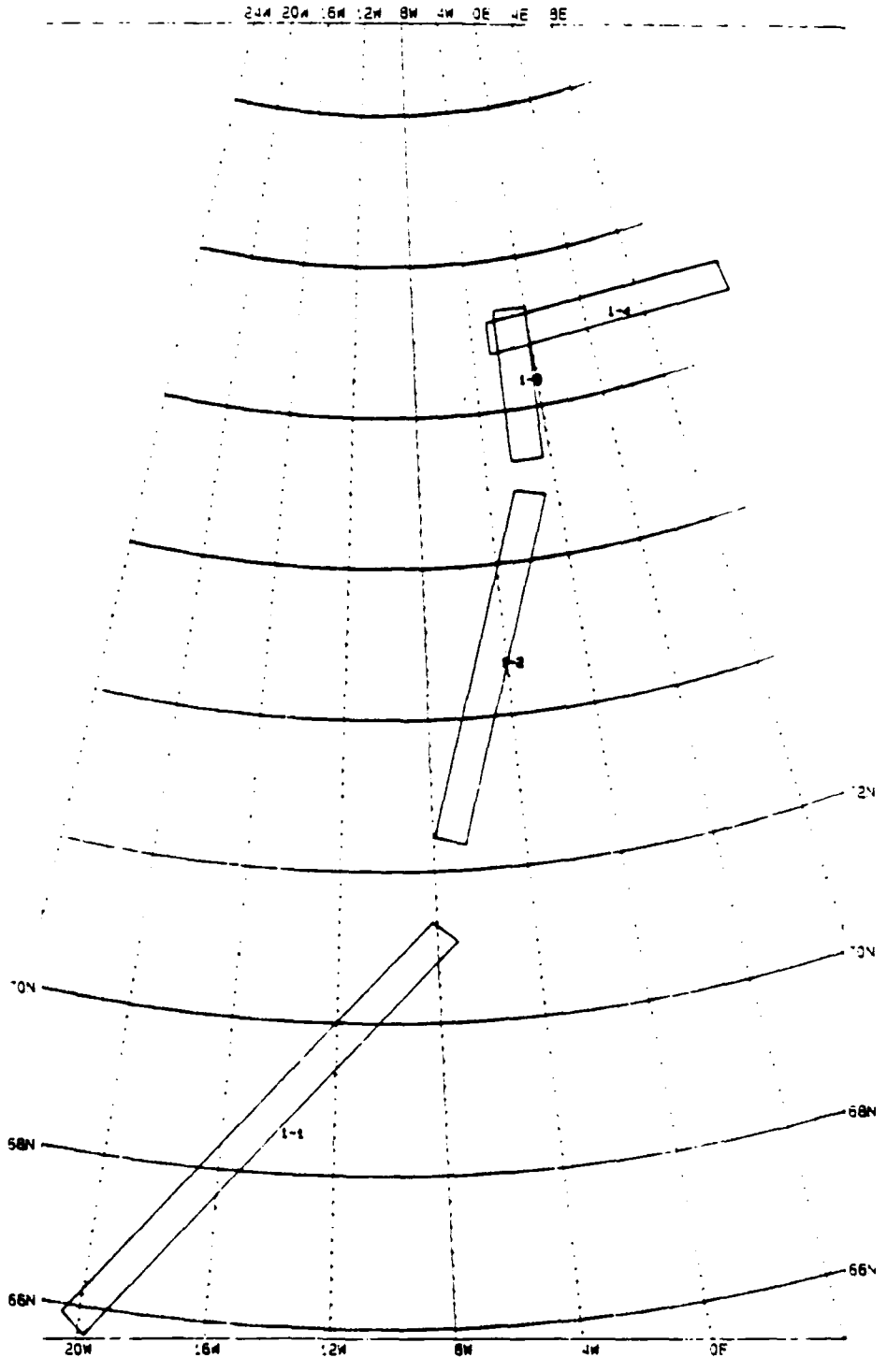


Figure 3. Area of SAR Coverage for MIZEX Mission 1, 27 March 1987

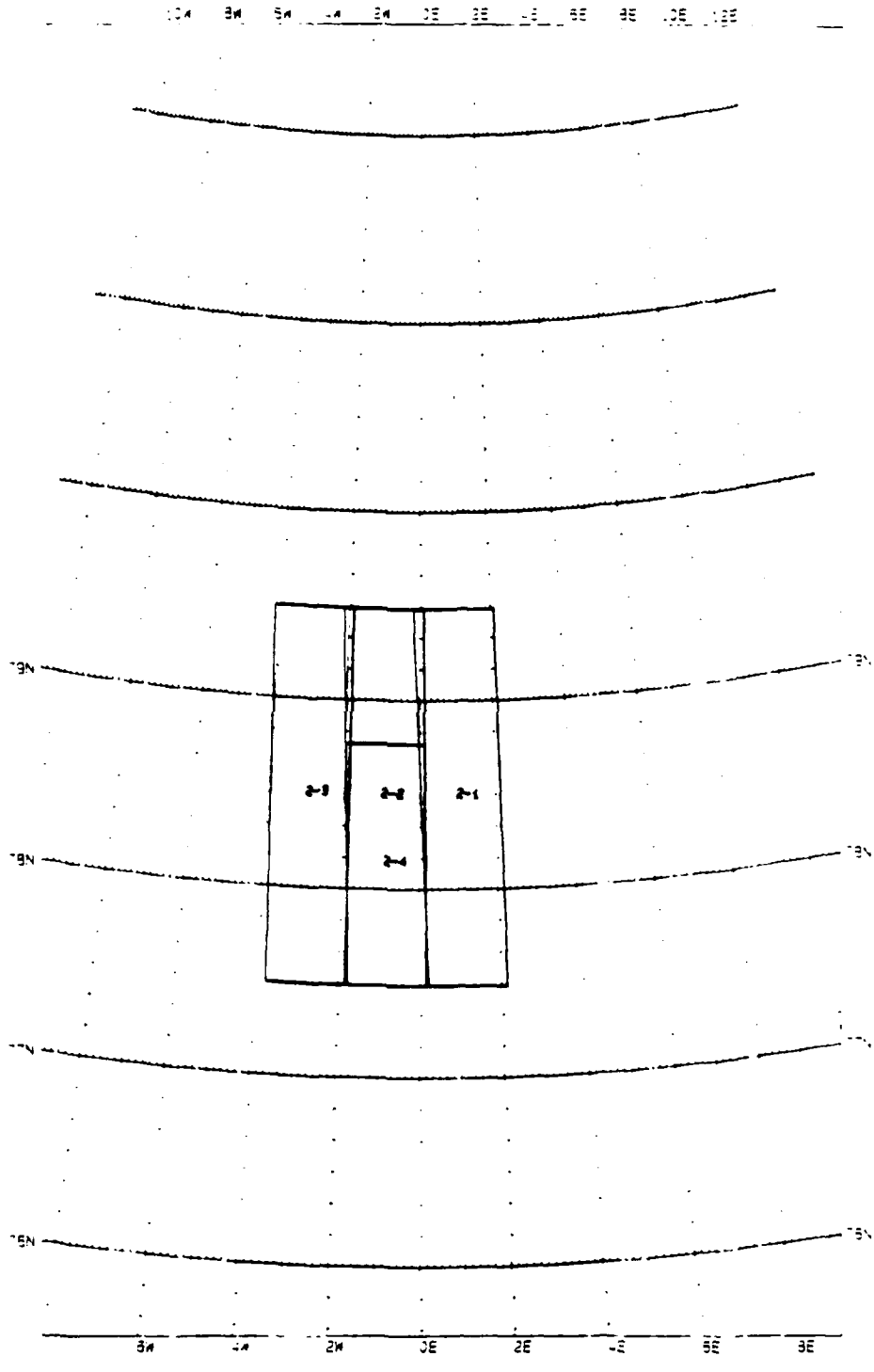


Figure 4. Area of SAR Coverage for MIZEX Mission 2, 28 March 1987

87-10754 R1

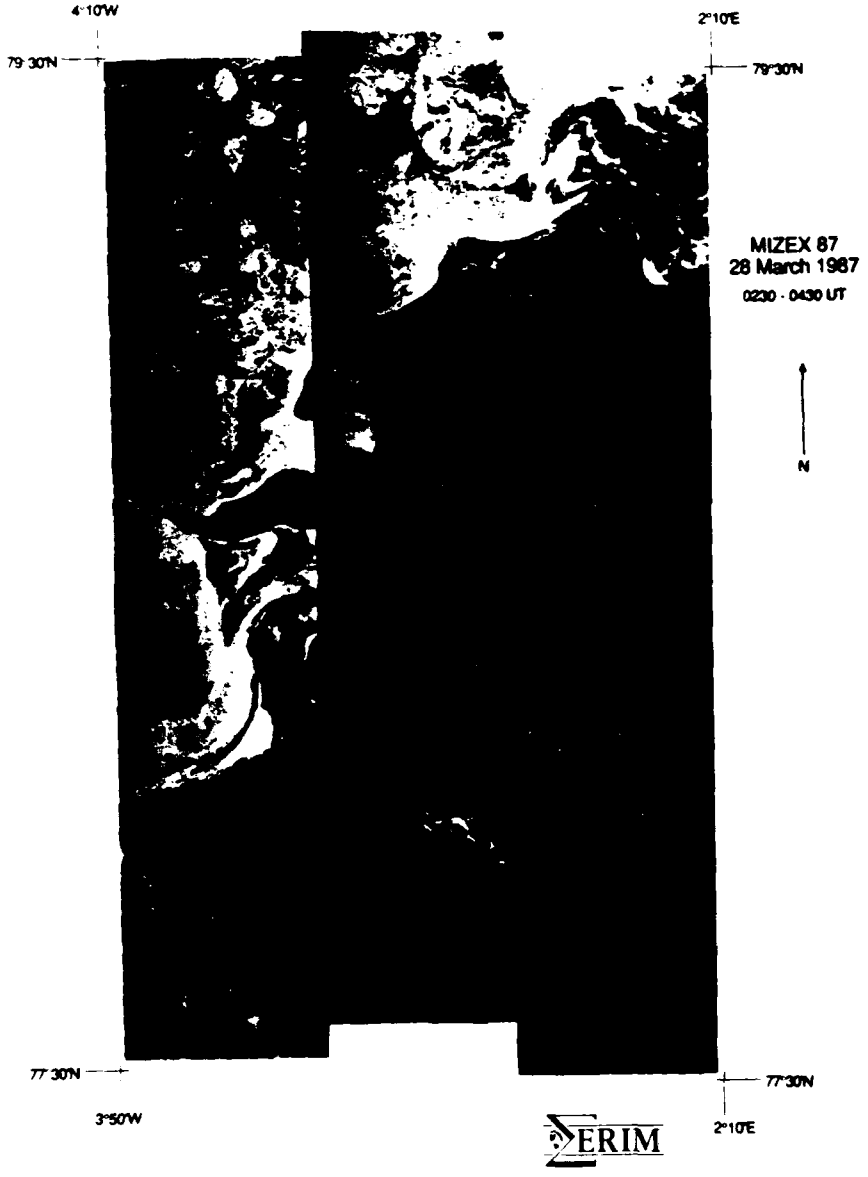


Figure 5. Mosaic of Real-Time Imagery for Mission 2

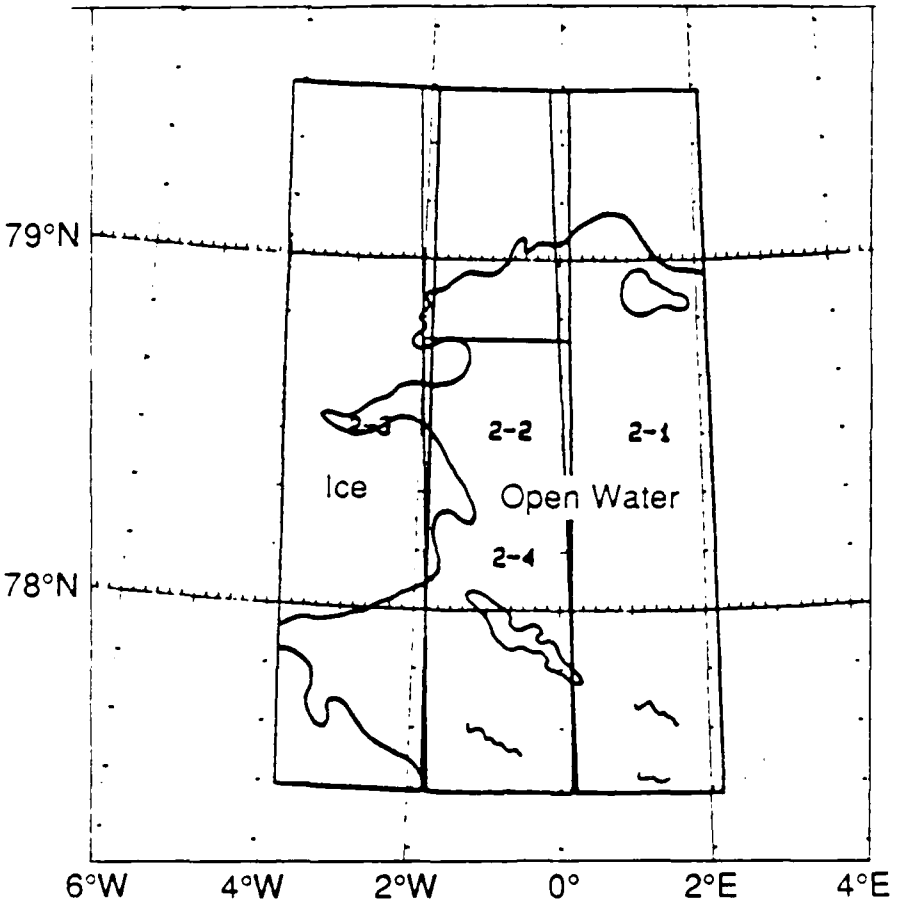


Figure 6. Ice Edge Location for 28 March 1987, Mission 2

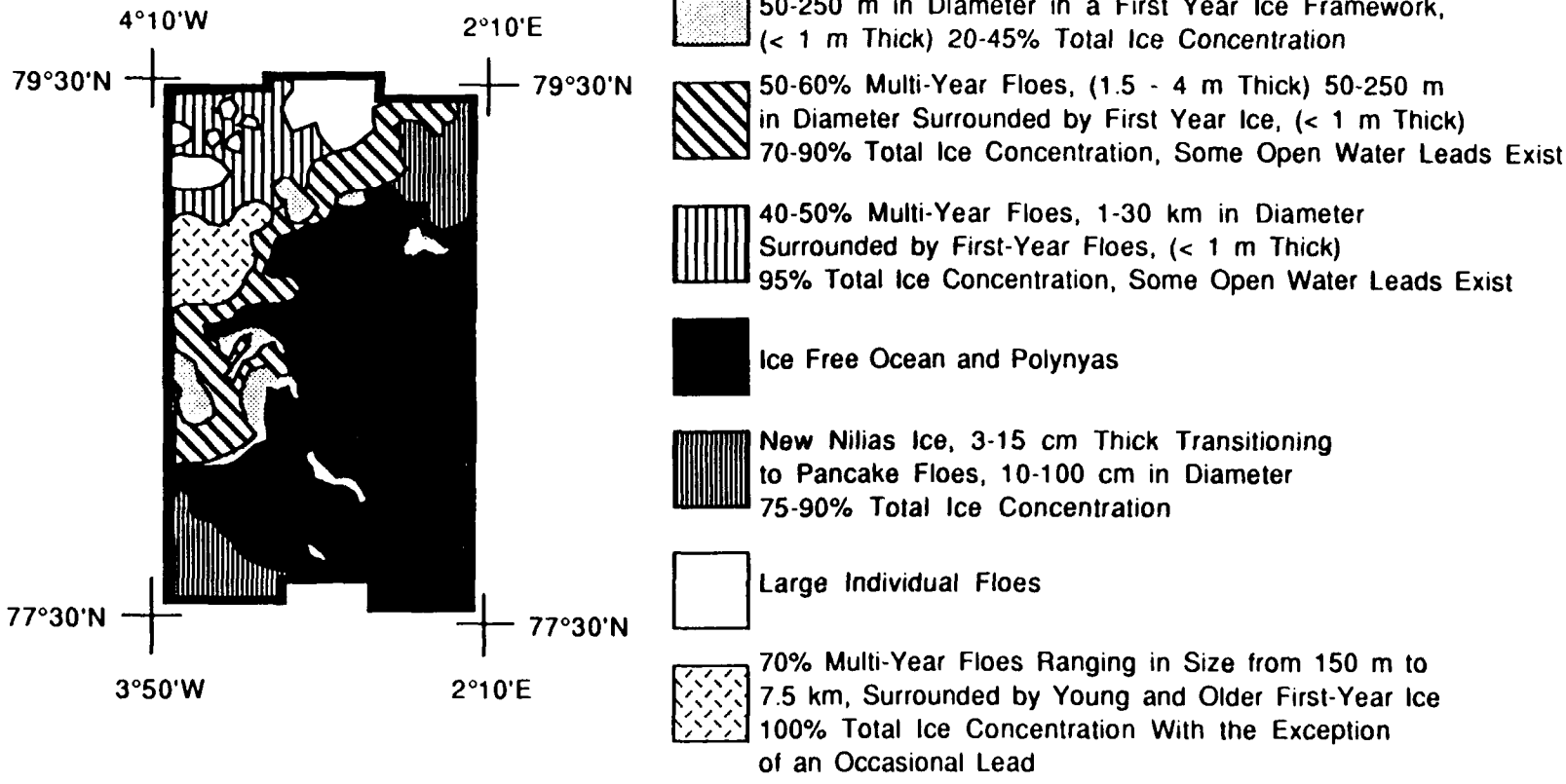


Figure 7. Ice Concentration and Floe Size Interpretation for Mission 2

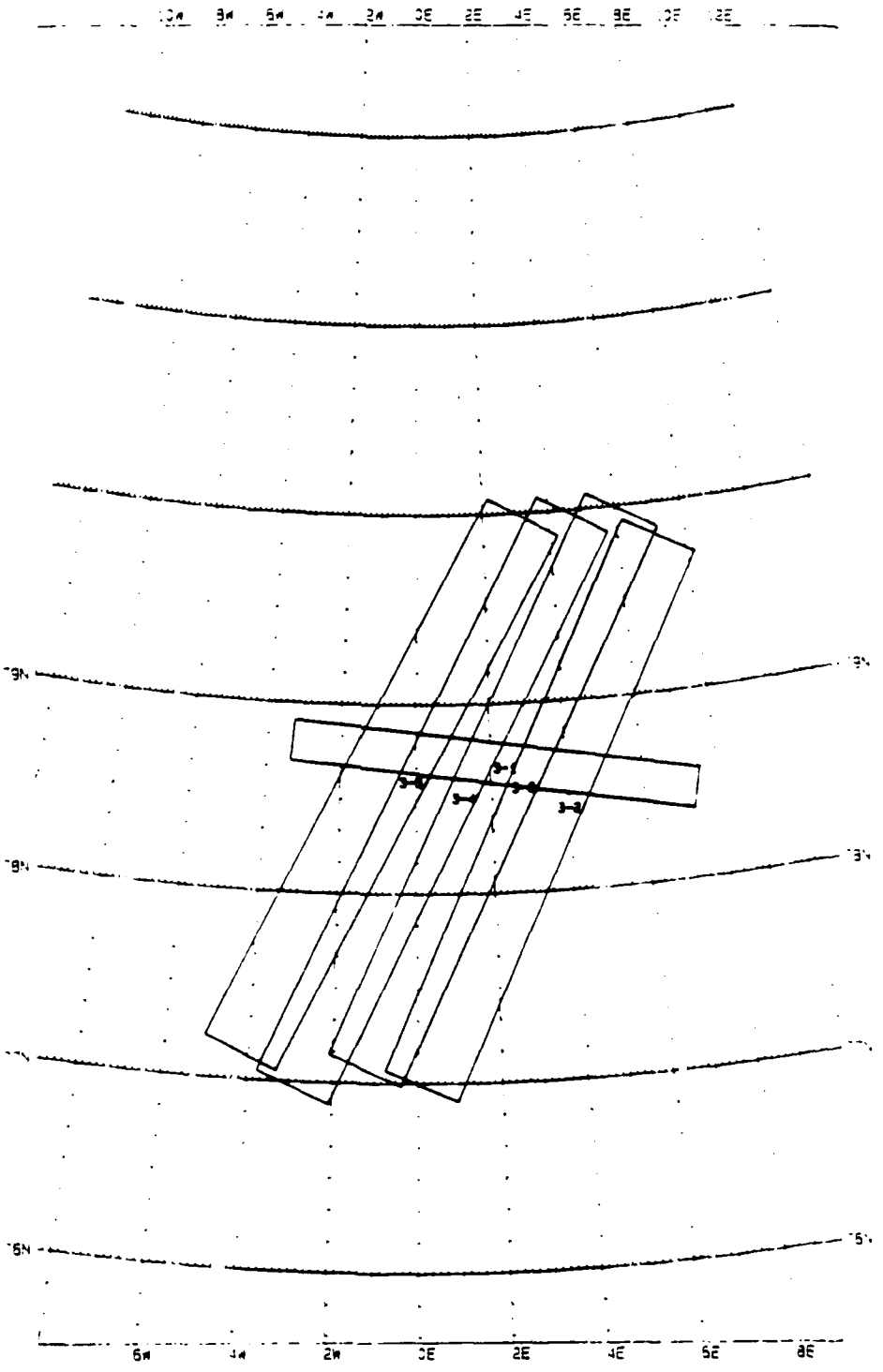


Figure 8. Area of SAR Coverage for MIZEX Mission 3, 28/29 March 1987

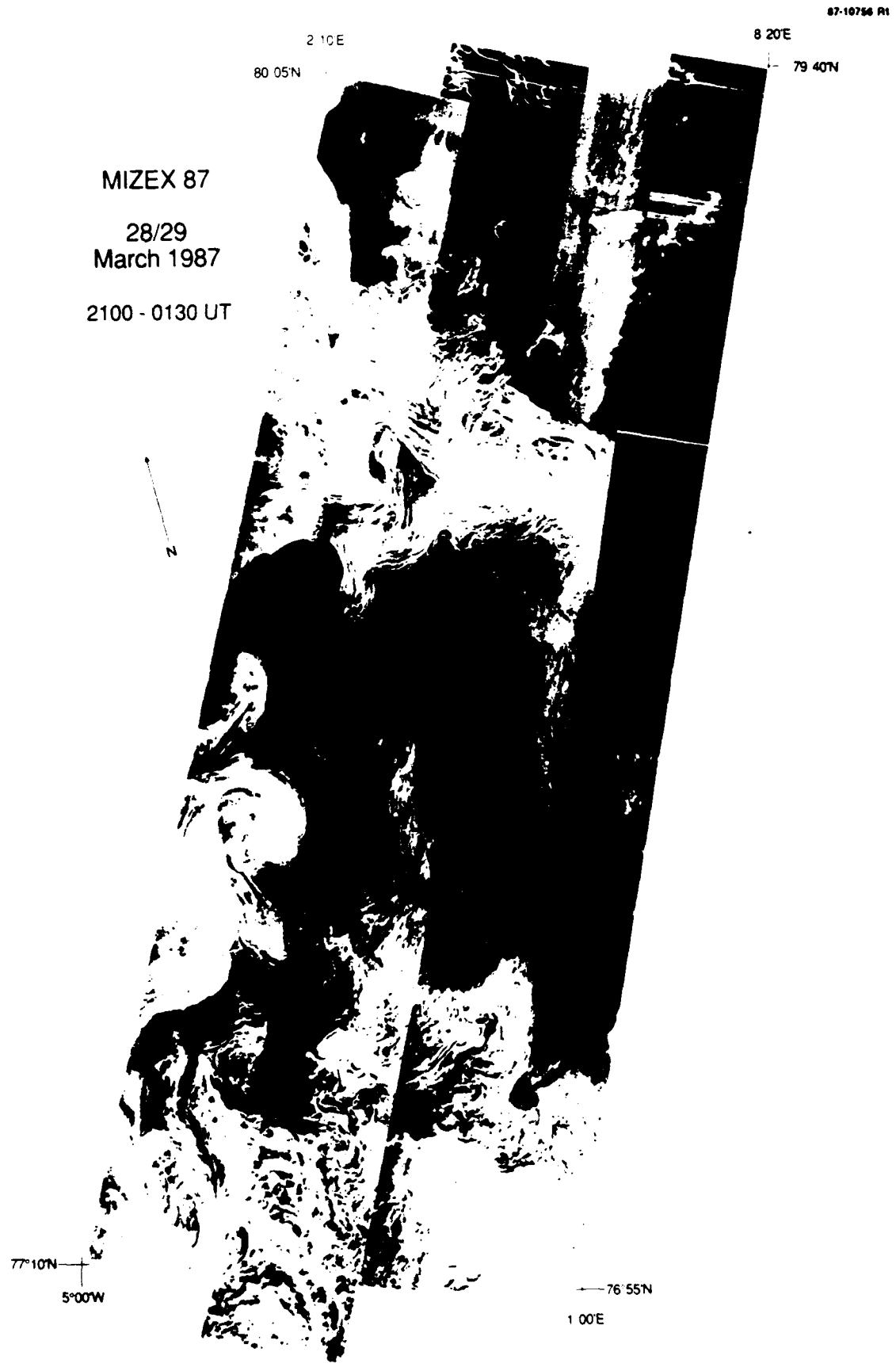


Figure 9. Mosaic of Real-Time Imagery for Mission 3

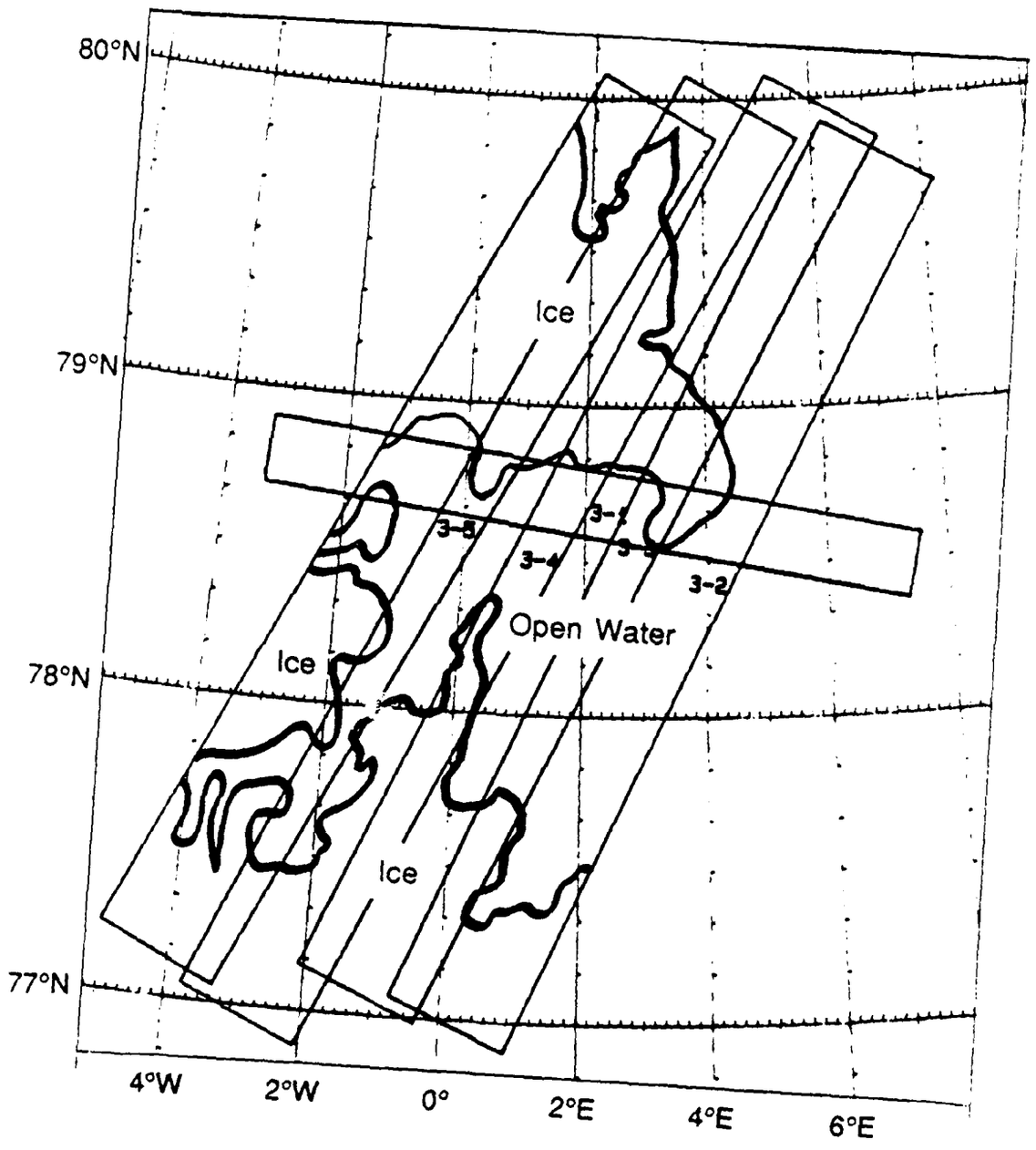
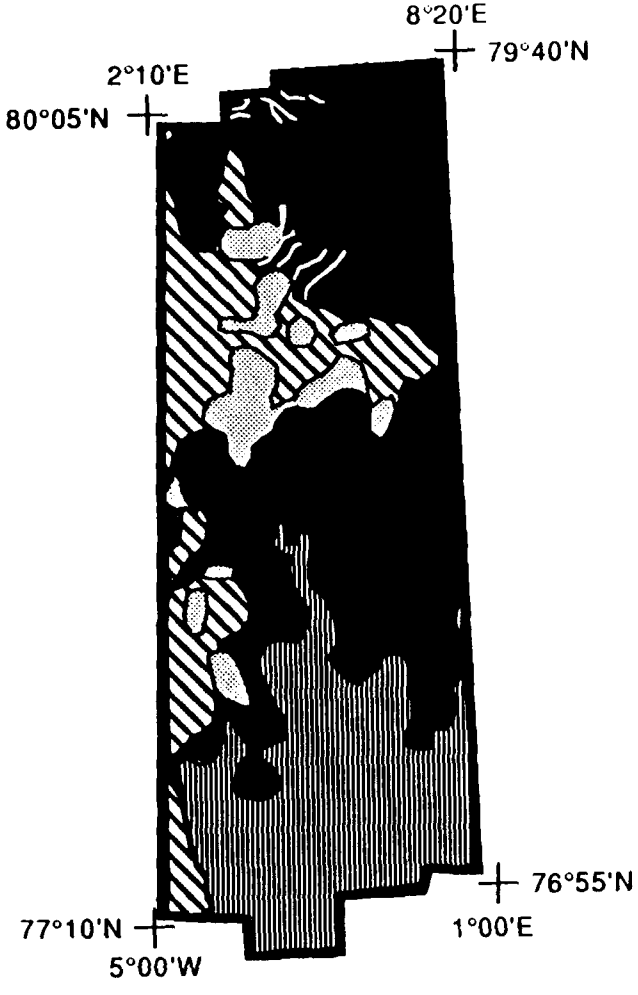


Figure 10. Ice Edge Location for 28/29 March 1987, Mission 3



50% Multi-Year Fragments, (1.5 - 3.5 m Thick), 50-250 m in Diameter in a First Year Ice Framework, (< 1 m Thick) 20-45% Total Ice Concentration

50-60% Multi-Year Floes, (1.5 - 4 m Thick) 50-250 m in Diameter Surrounded by First Year Ice, (< 1 m Thick) 70-90% Total Ice Concentration, Some Open Water Leads Exist

40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 11. Ice Concentration and Floe Size Interpretation for Mission 3

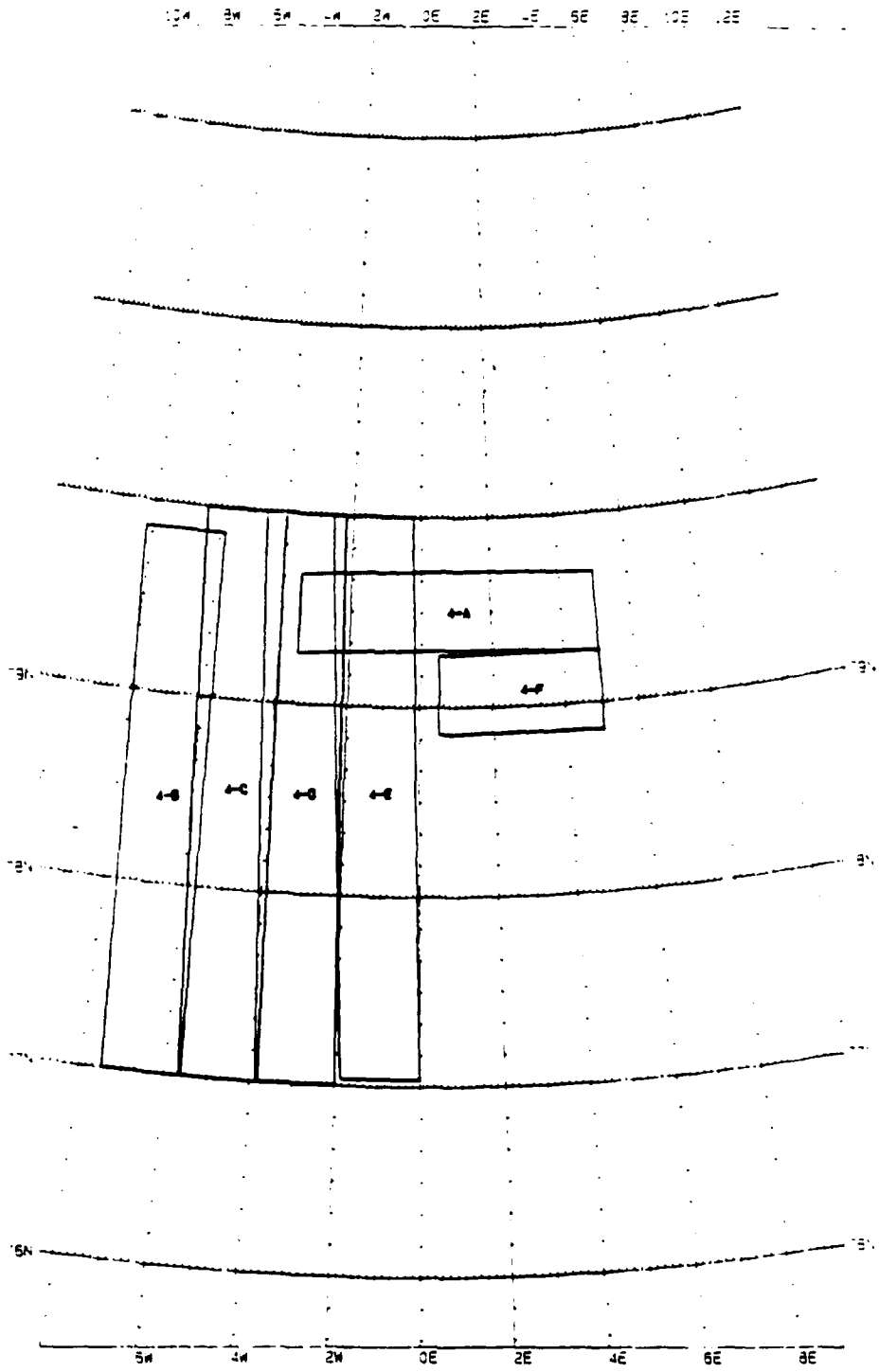


Figure 12. Area of SAR Coverage for MIZEX Mission 4, 30 March 1987

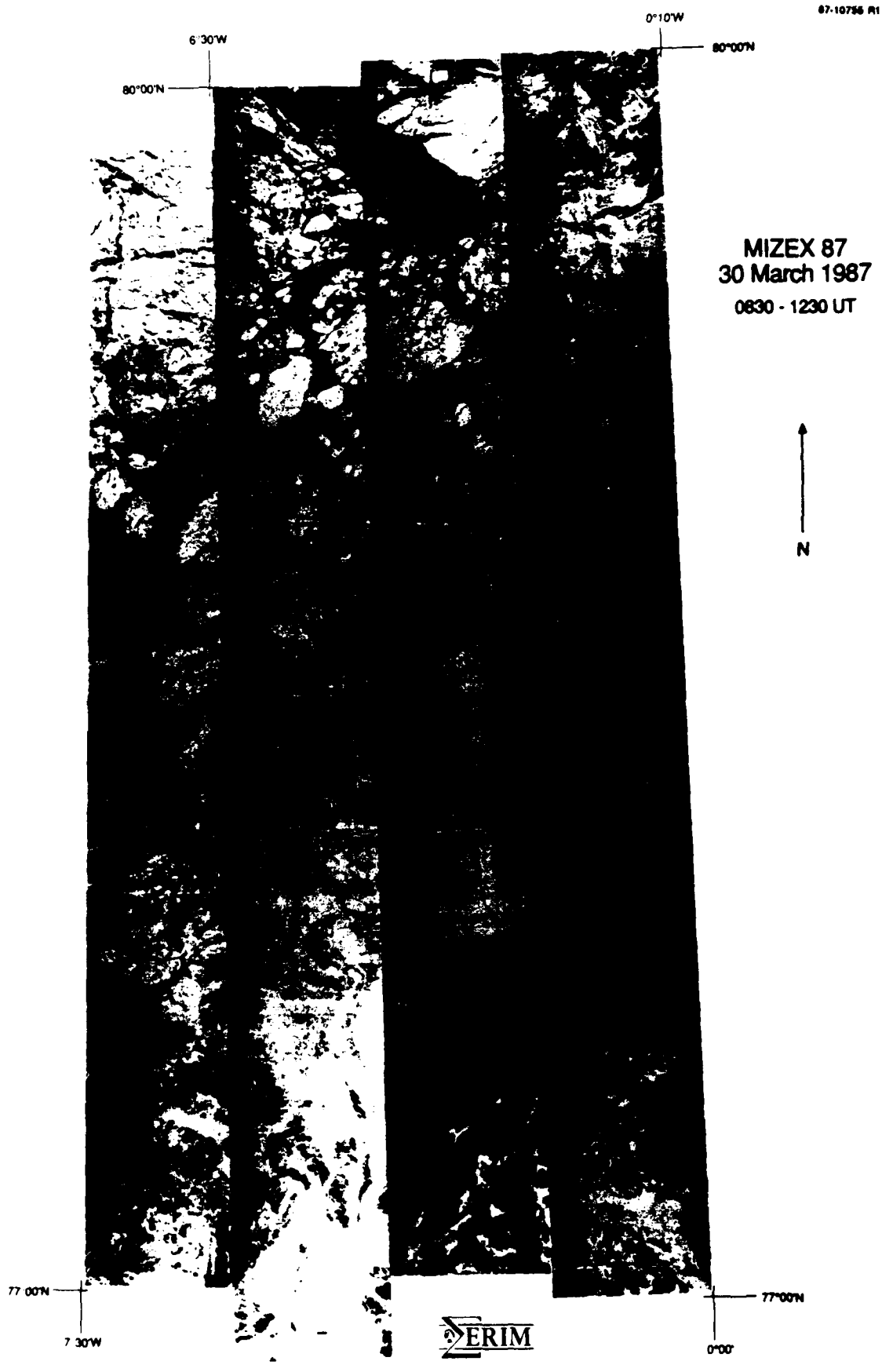


Figure 13. Mosaic of Real-Time Imagery for Mission 4

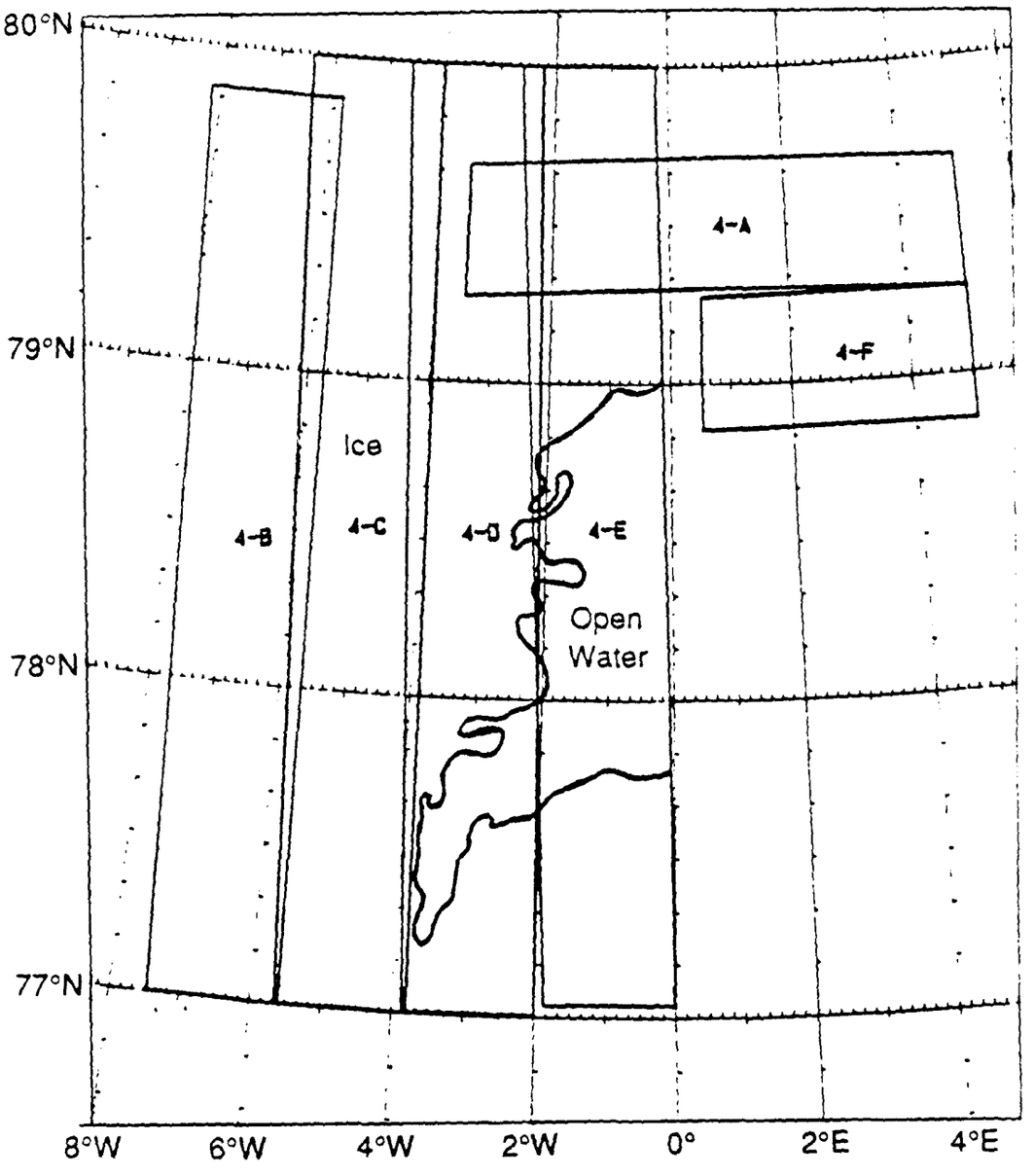


Figure 14. Ice Edge Location for 30 March 1987, Mission 4

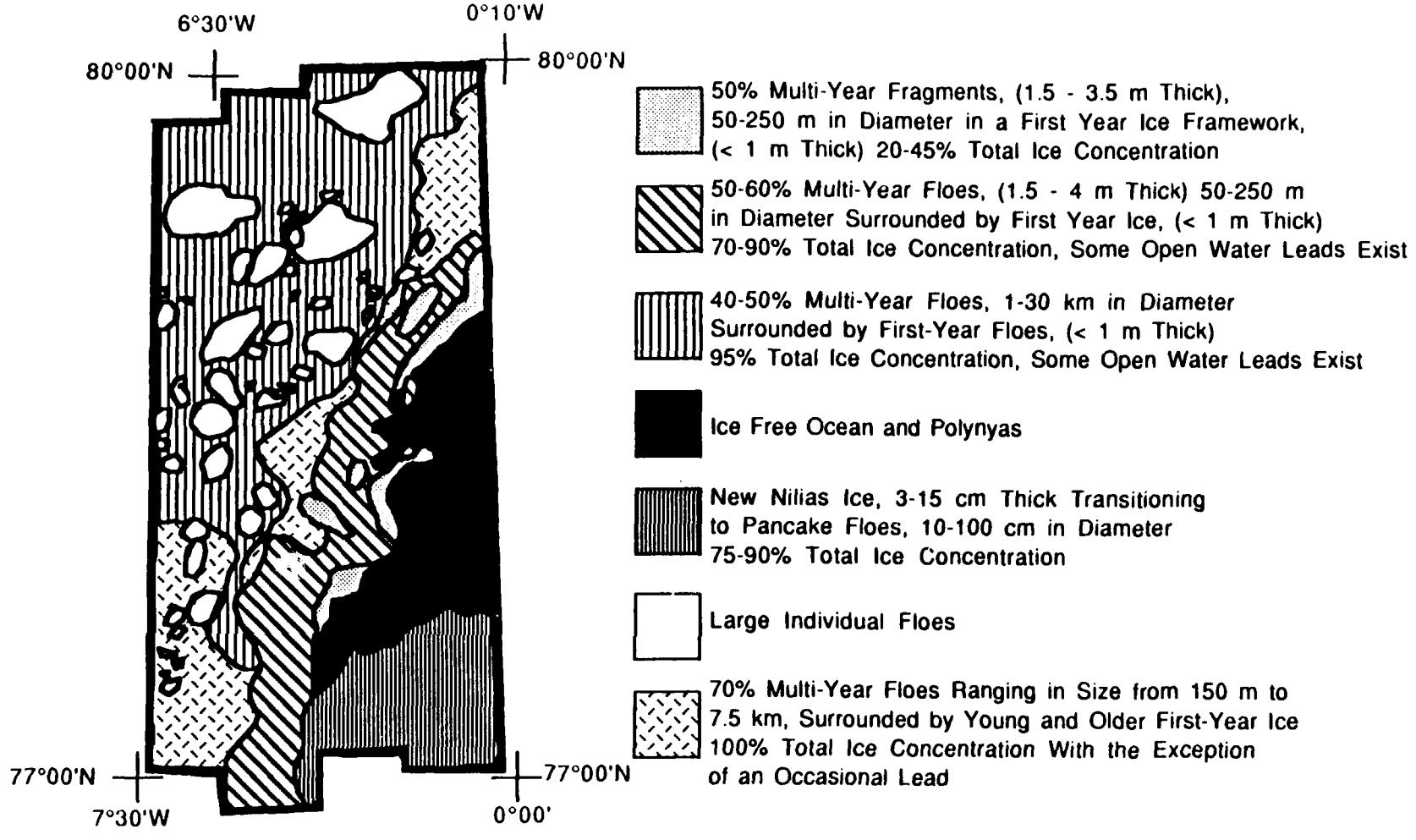


Figure 15. Ice Concentration and Floe Size Interpretation for Mission 4

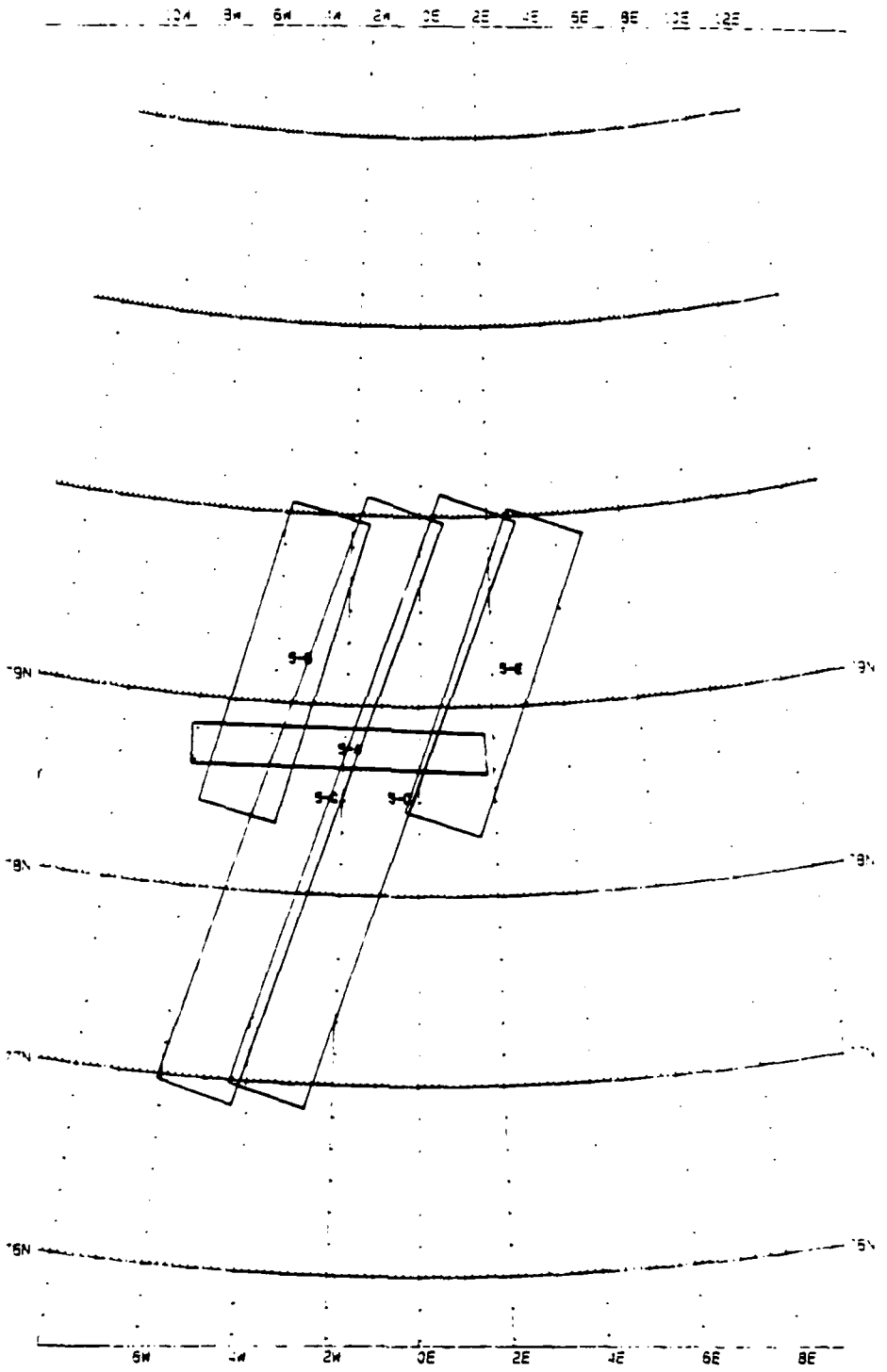


Figure 16. Area of SAR Coverage for MIZEX Mission 5, 31 March 1987

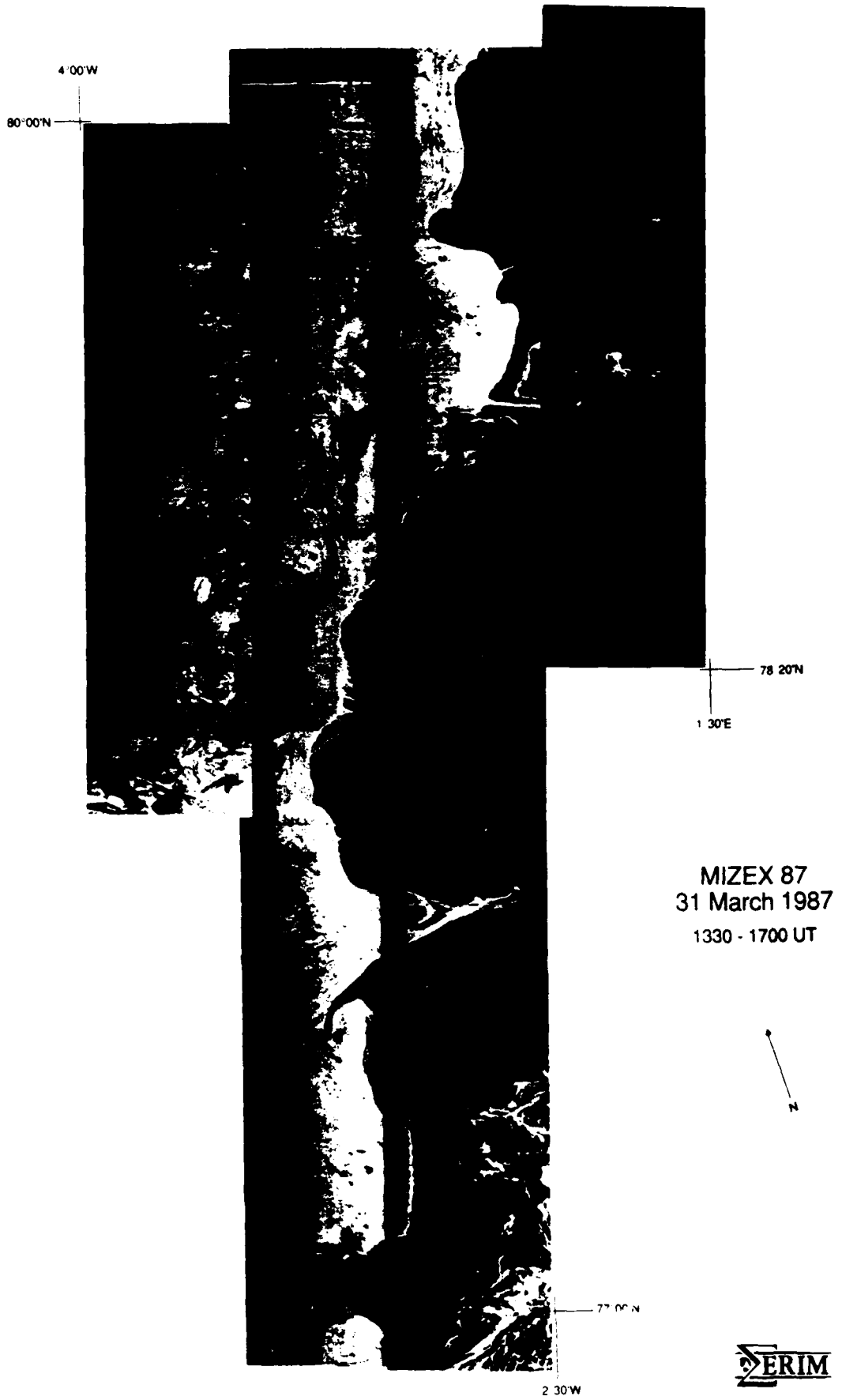


Figure 17. Mosaic of Real-Time Imagery for Mission 5

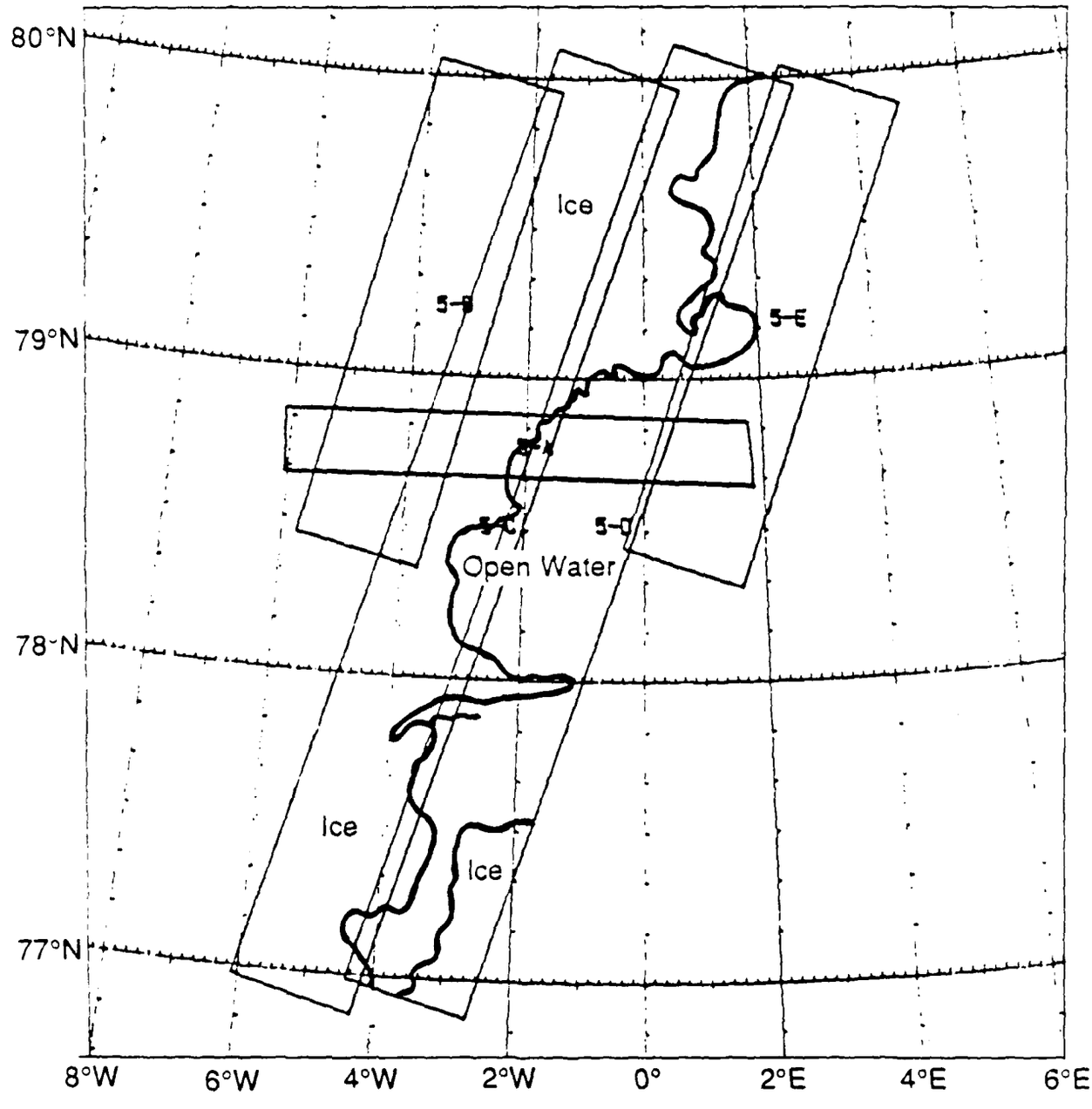


Figure 18. Ice Edge Location for 31 March 1987, Mission 5

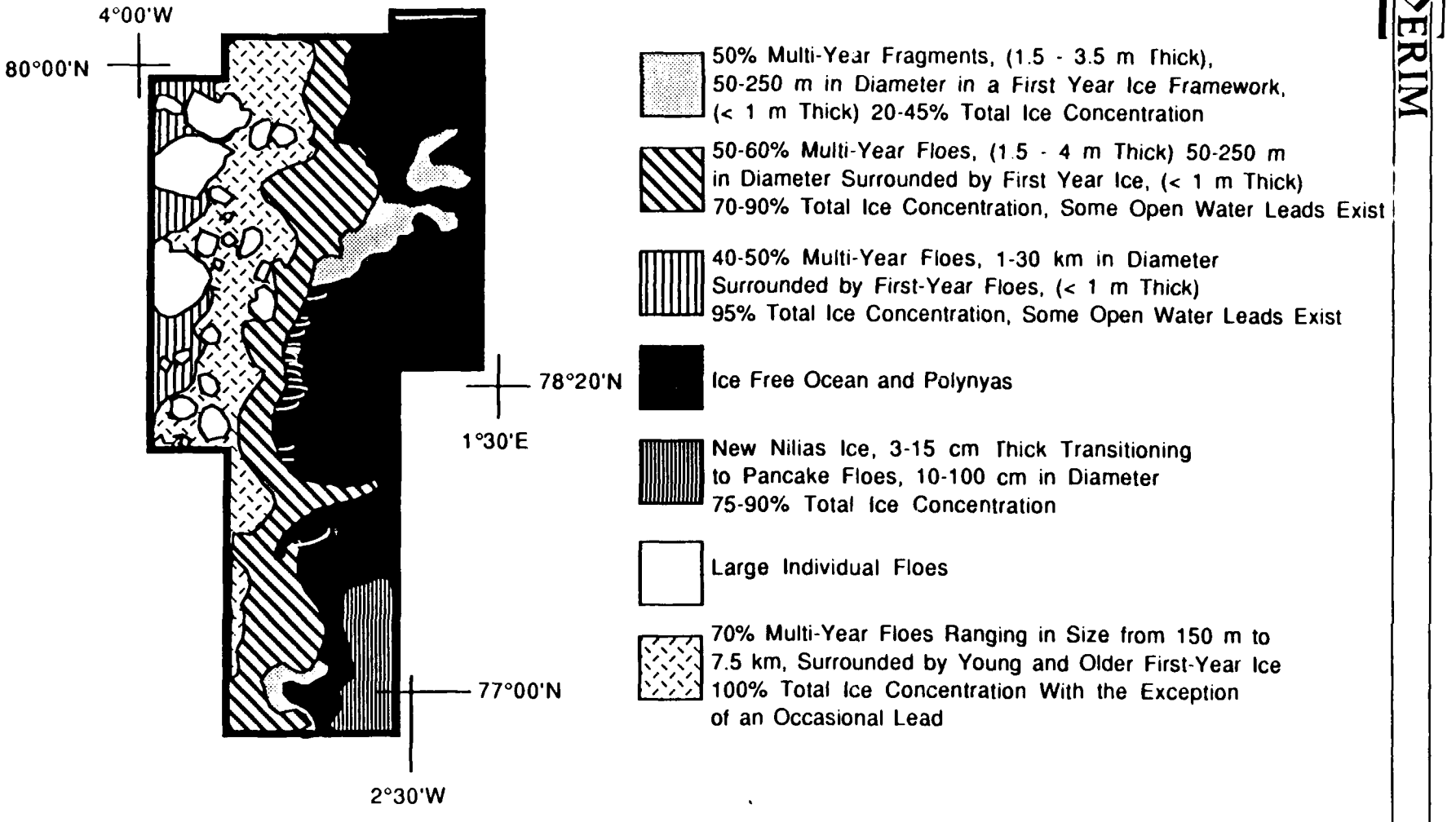


Figure 19. Ice Concentration and Floe Size Interpretation for Mission 5

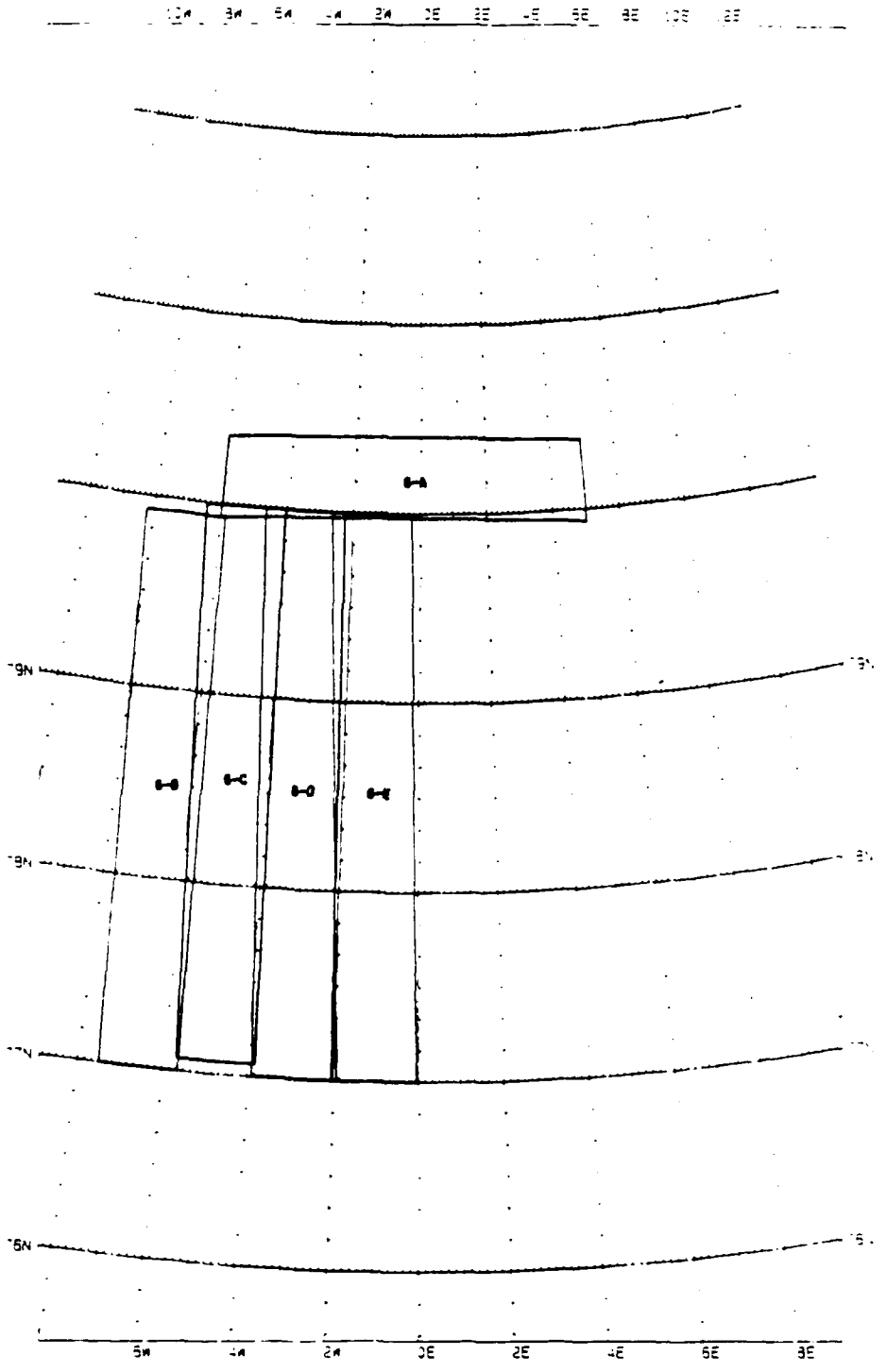


Figure 20. Area of SAR Coverage for MIZEX Mission 6, 31 March/1 April 1987

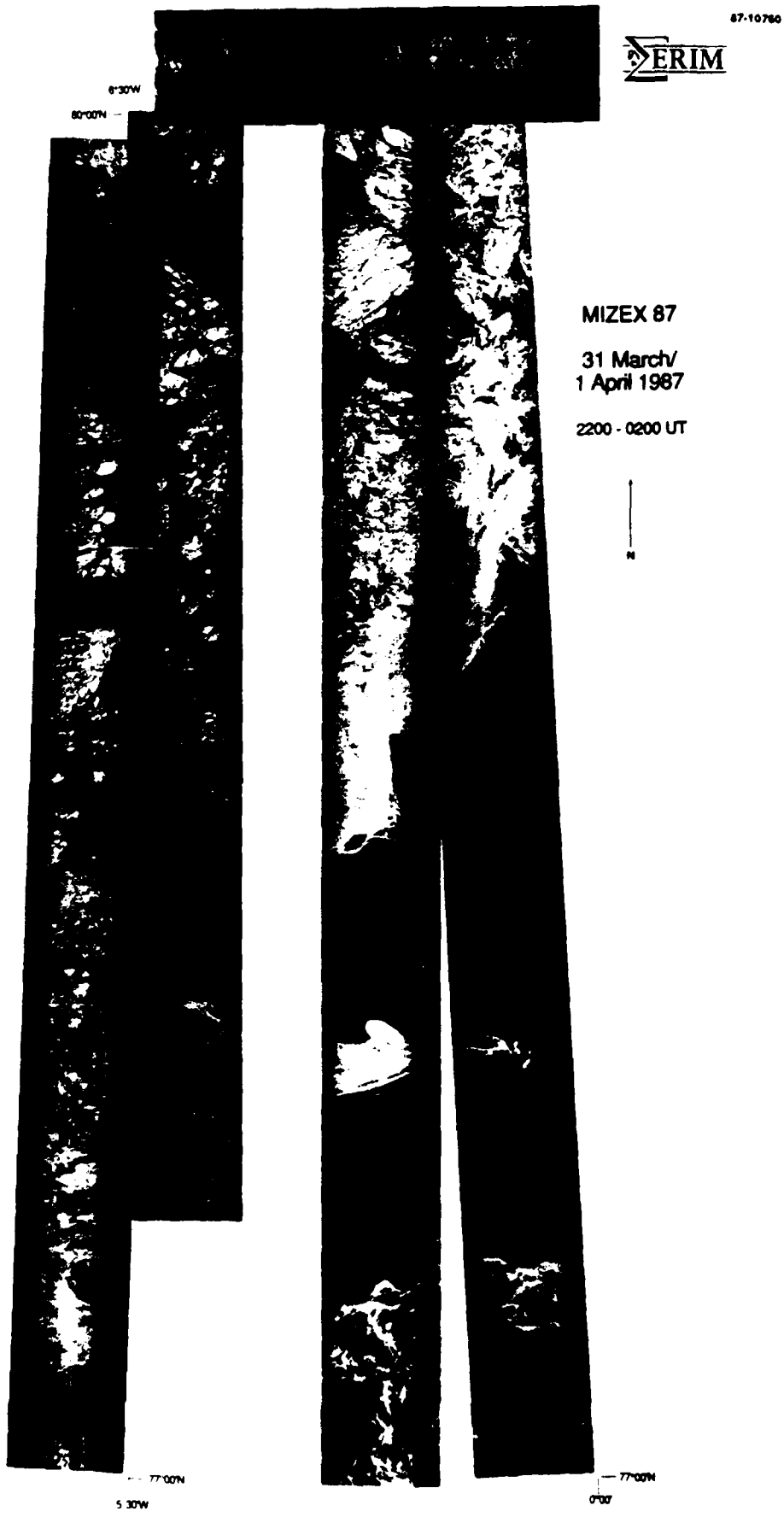


Figure 21. Mosaic of Real-Time Imagery for Mission 6

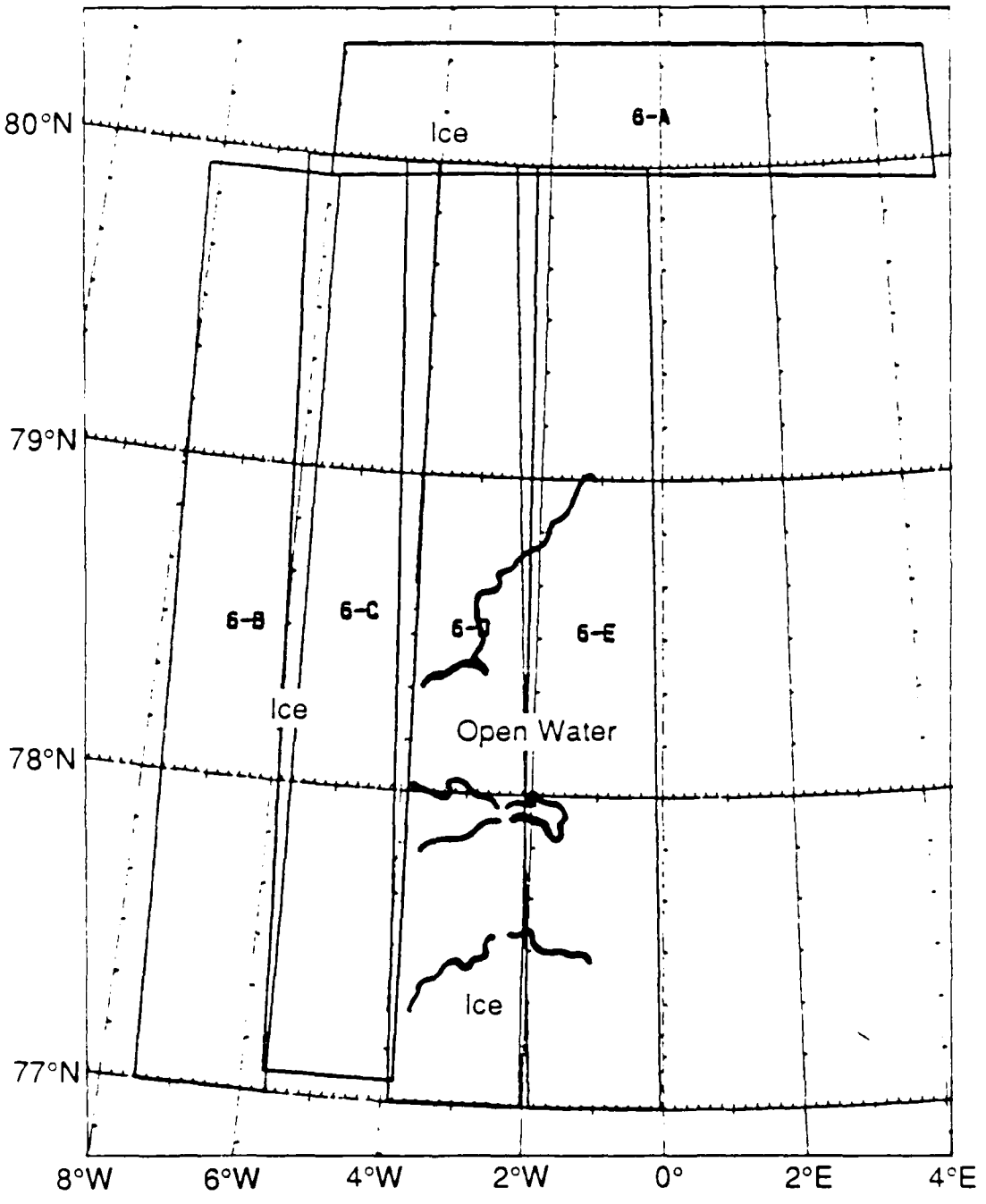


Figure 22. Ice Edge Location for 31 March/1 April 1987, Mission 6

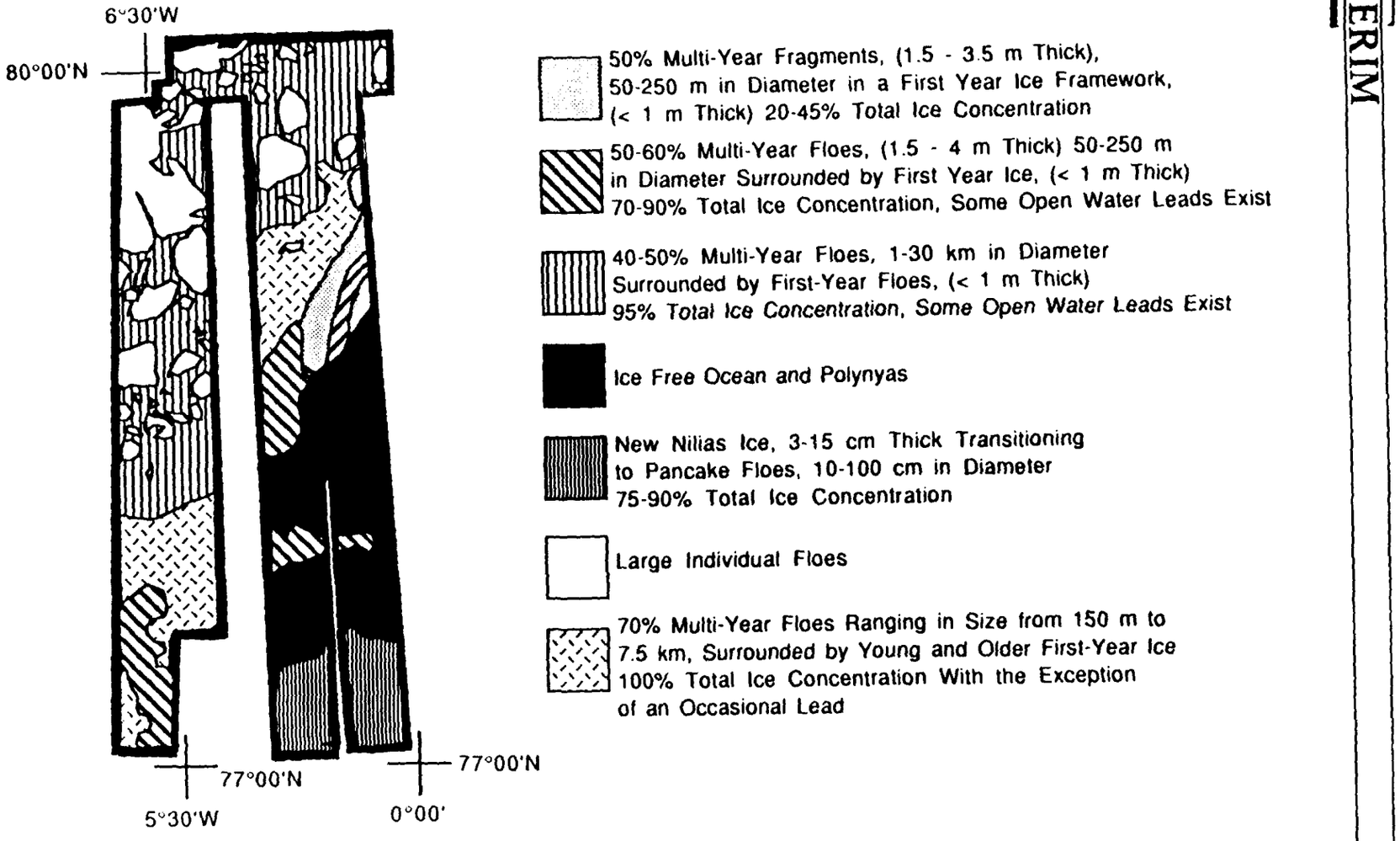


Figure 23. Ice Concentration and Floe Size Interpretation for Mission 6

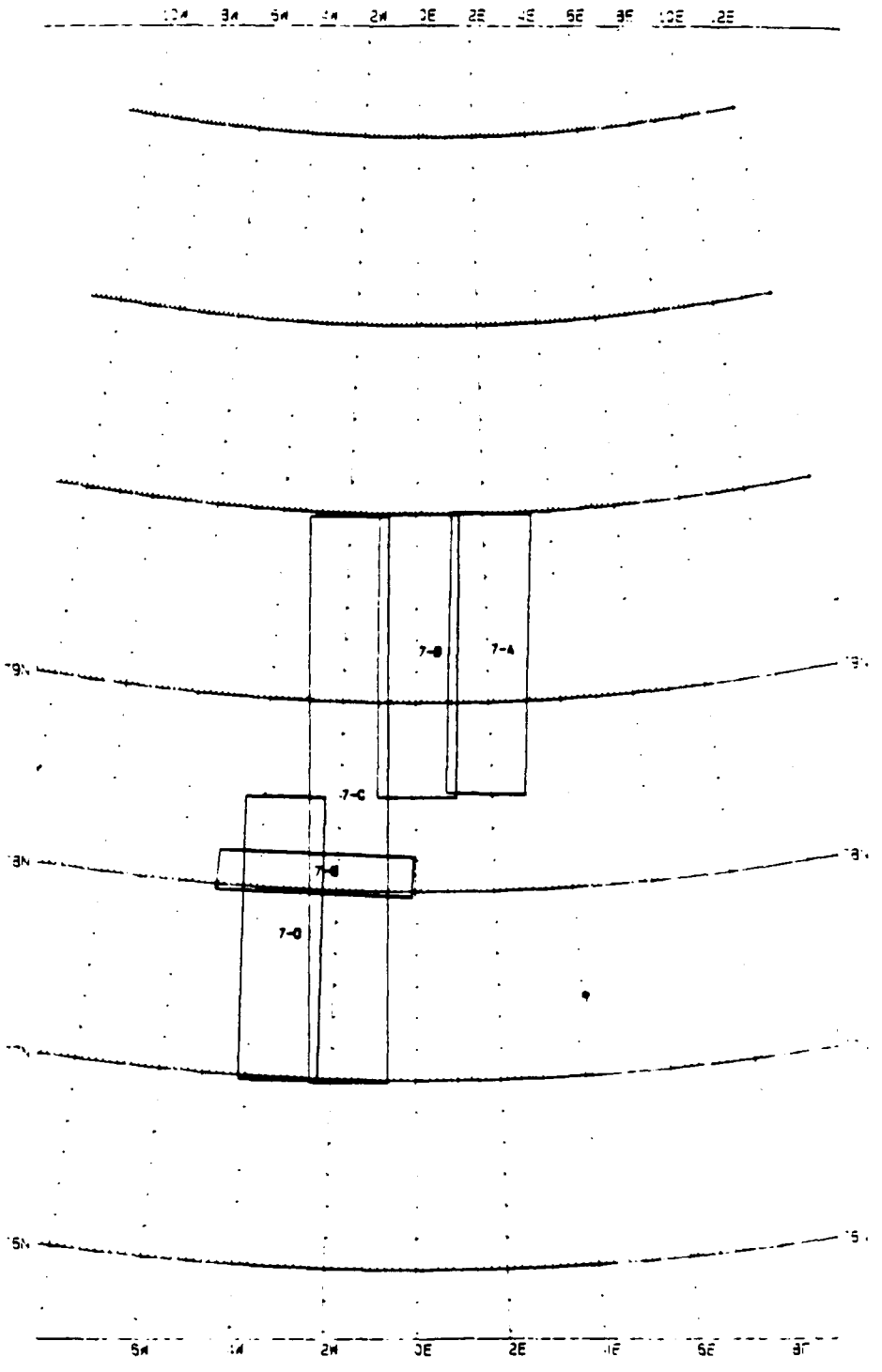


Figure 24. Area of SAR Coverage for MIZEX Mission 7, 1 April 1987

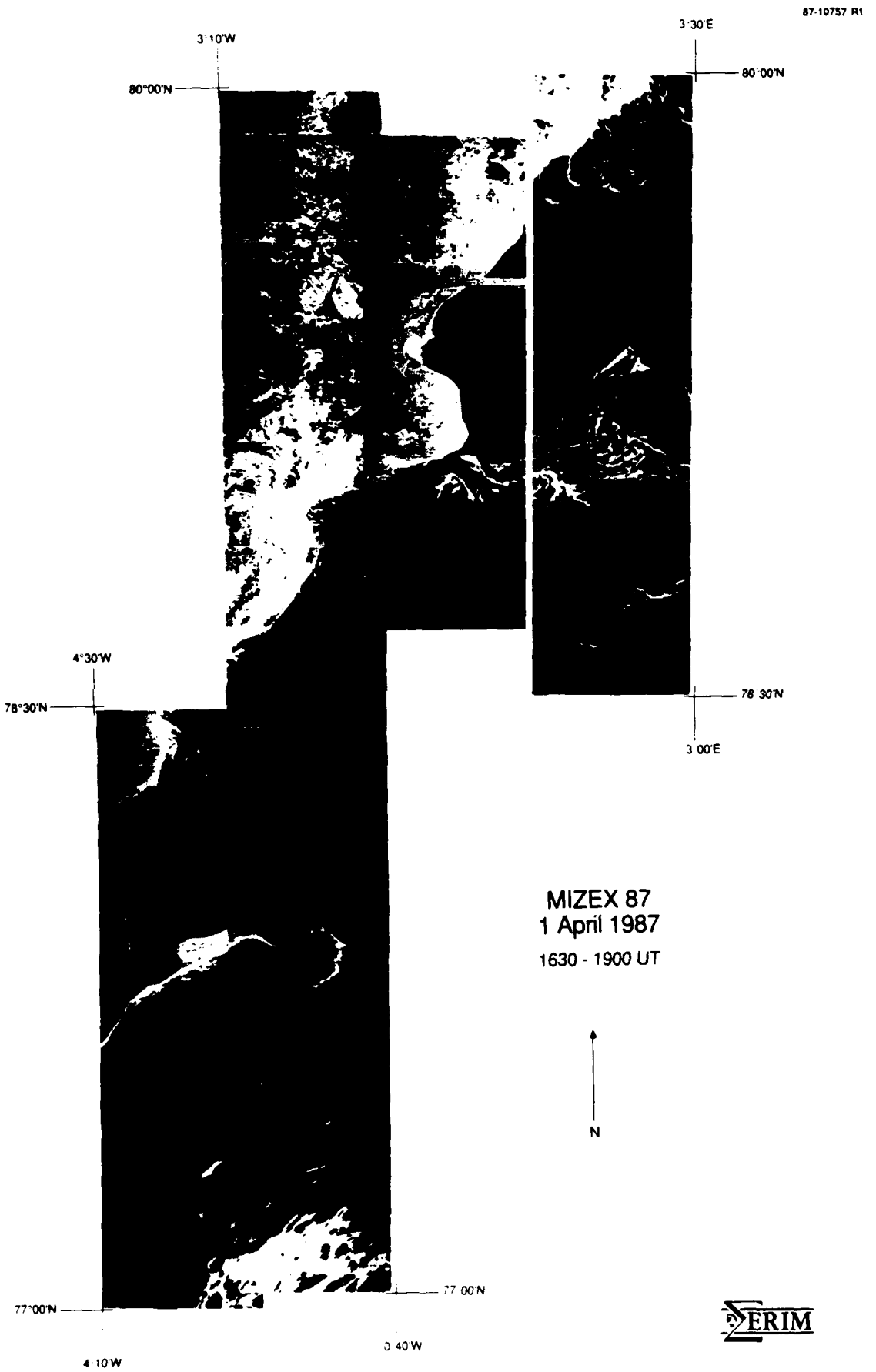


Figure 25. Mosaic of Real-Time Imagery for Mission 7

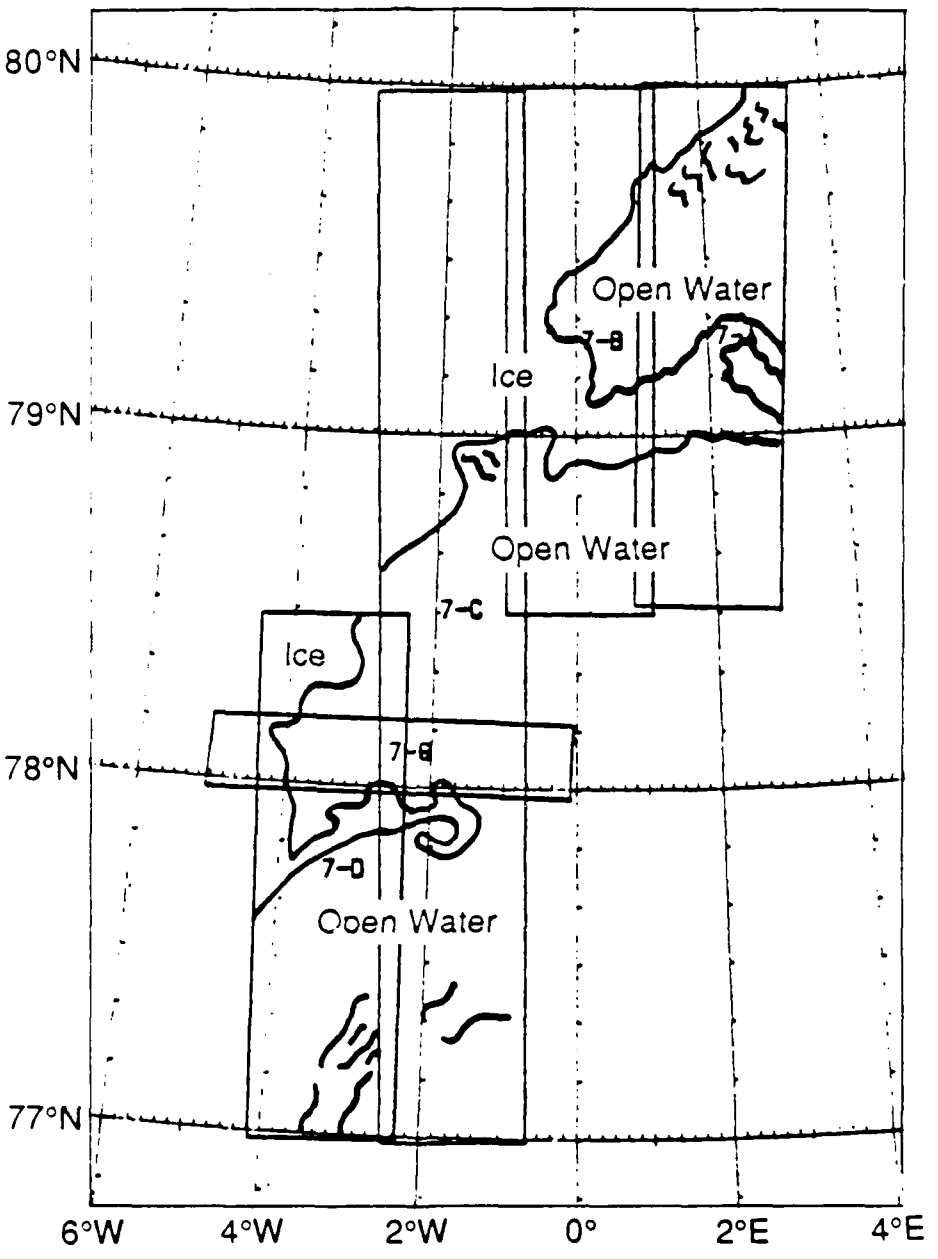


Figure 26. Ice Edge Location for 1 April 1987, Mission 7

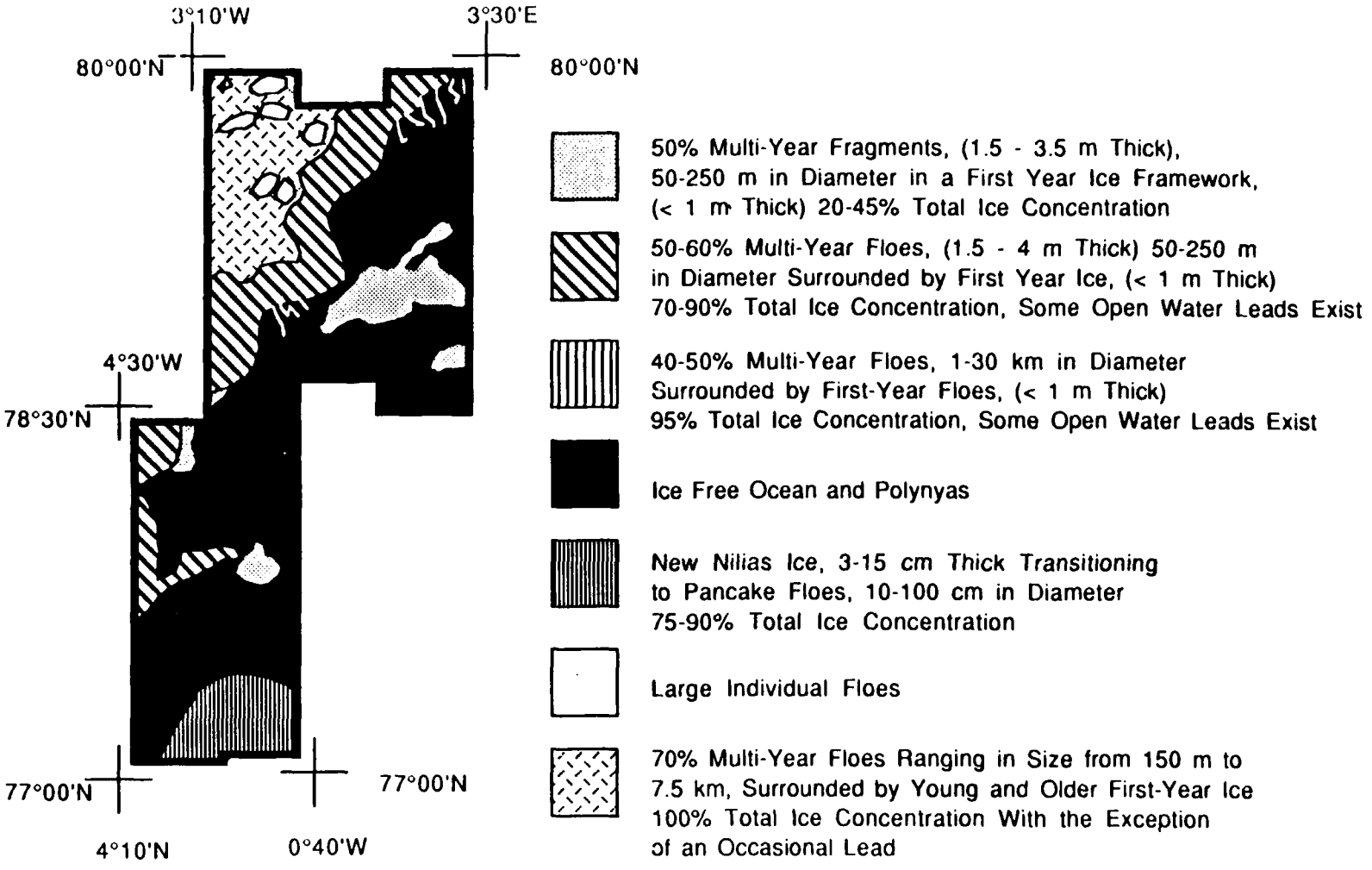


Figure 27. Ice Concentration and Floe Size Interpretation for Mission 7

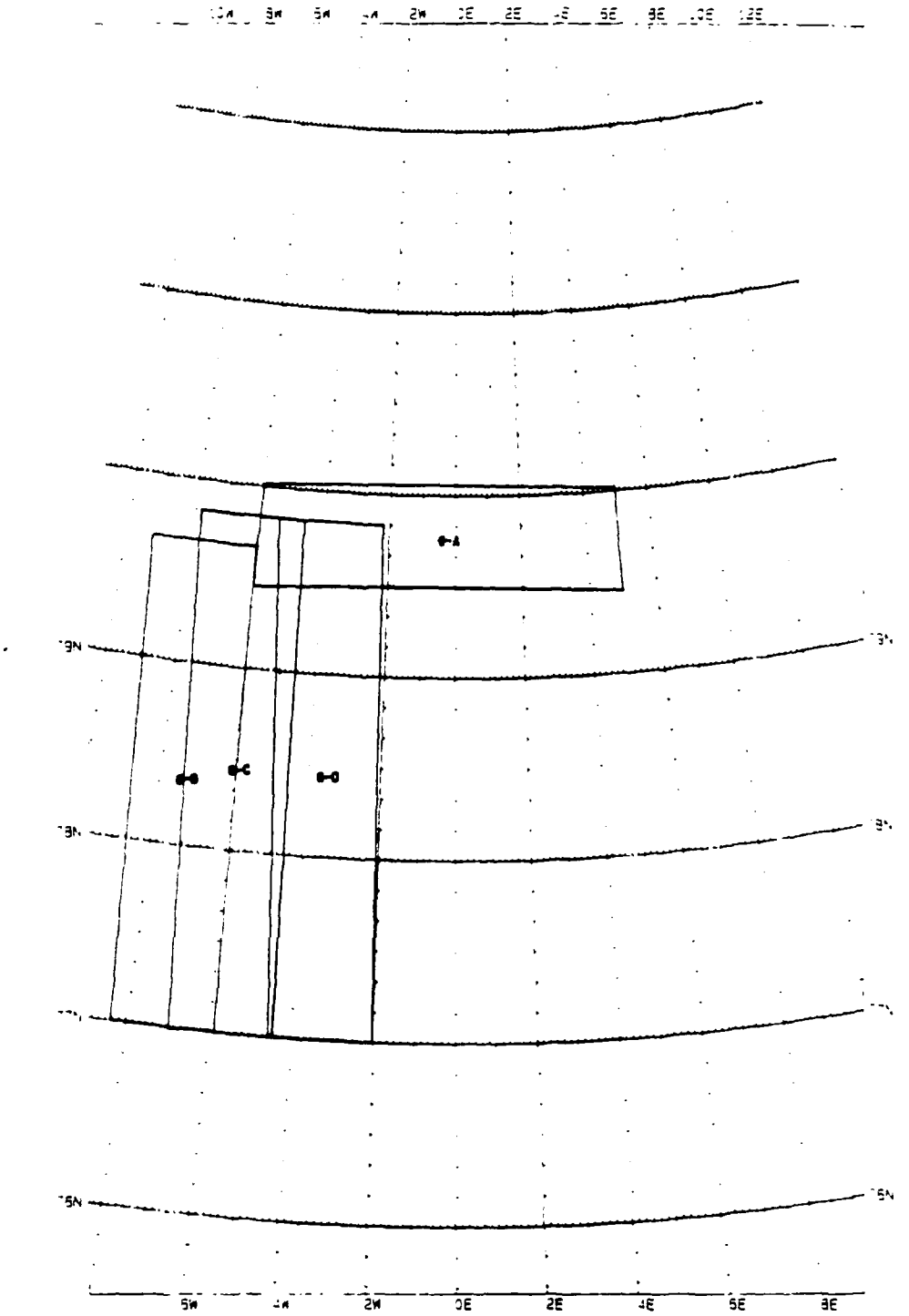


Figure 28. Area of SAR Coverage for MIZEX Mission 8, 2 April 1987

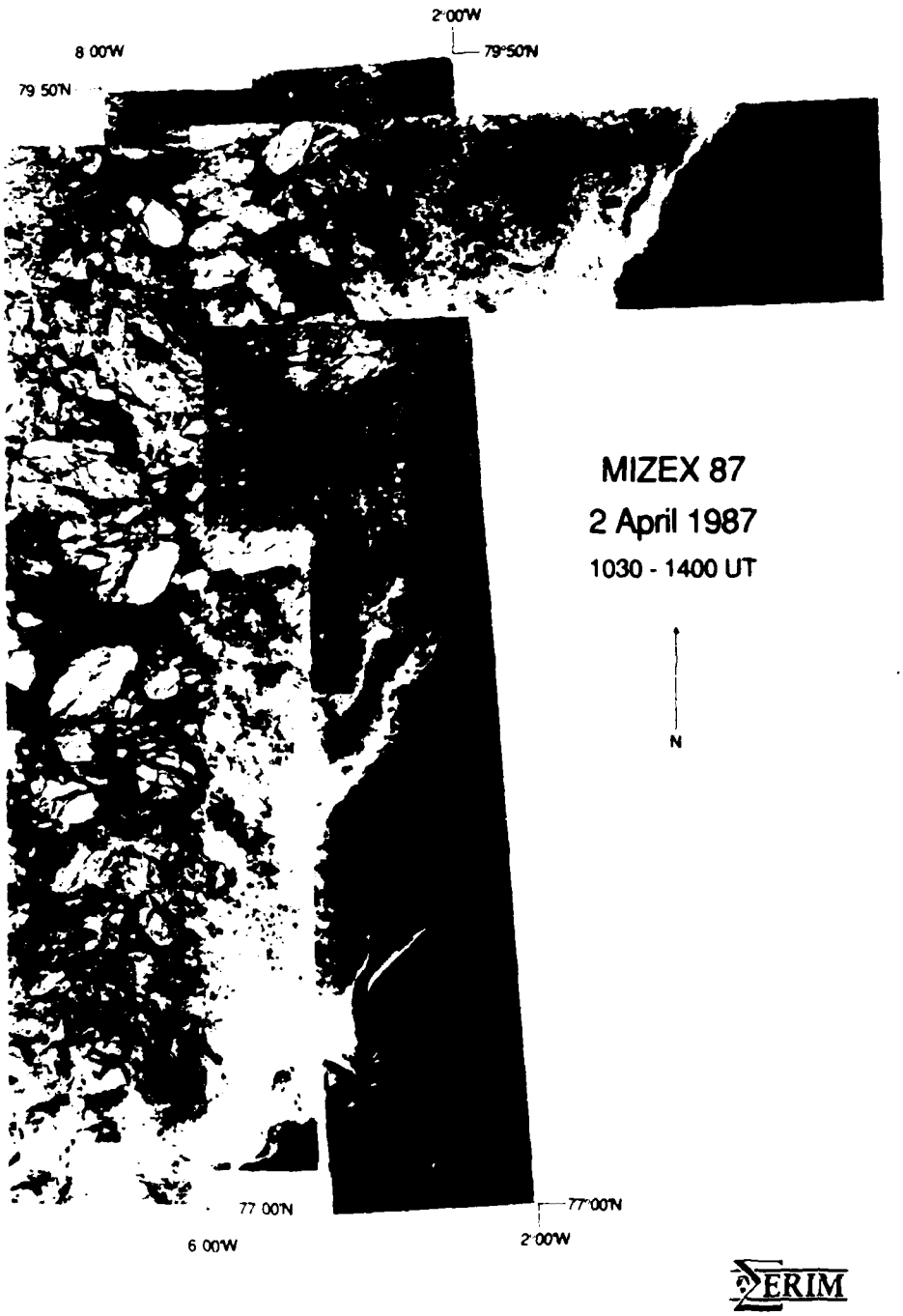


Figure 29. Mosaic of Real-Time Imagery for Mission 8

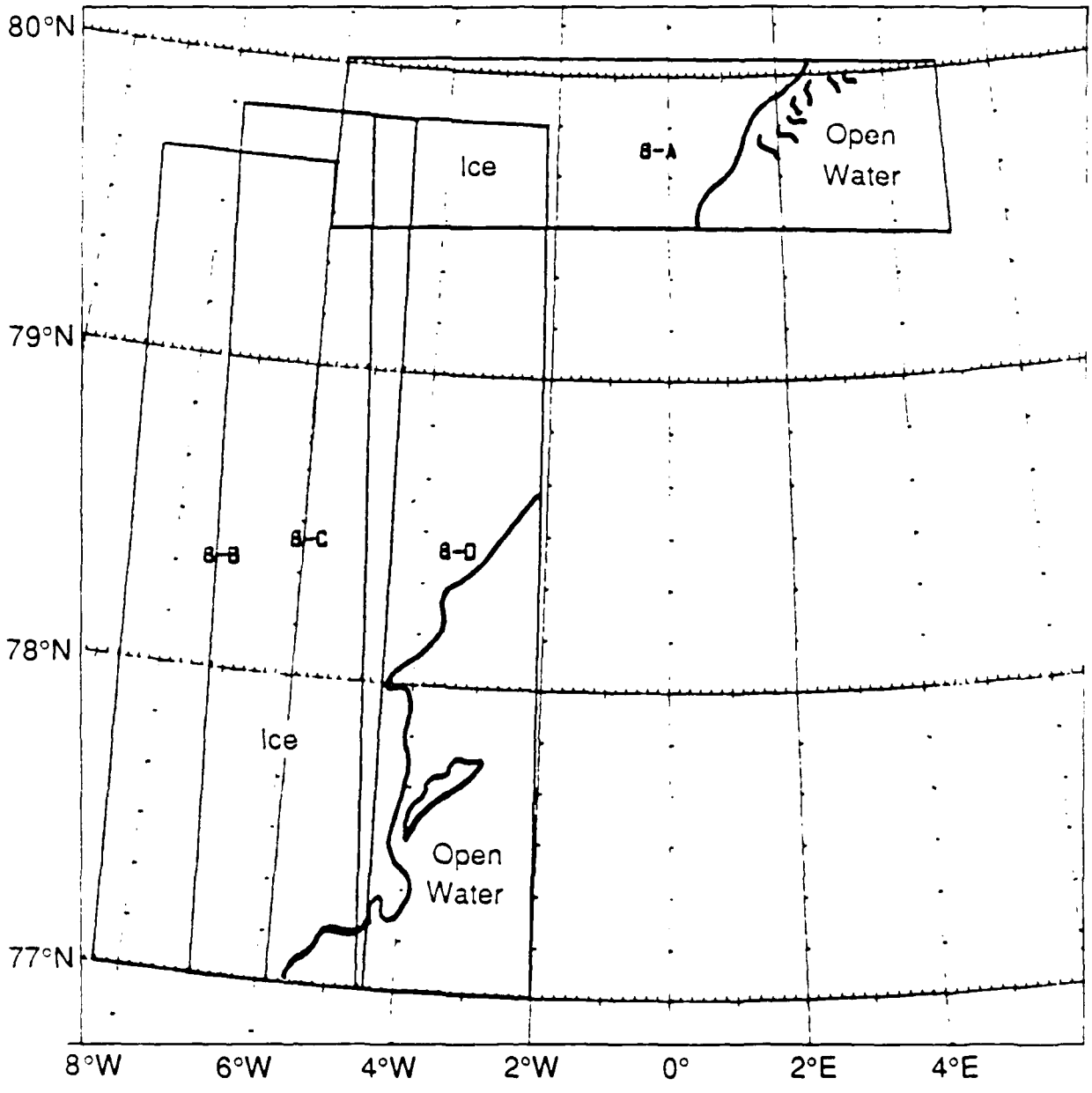
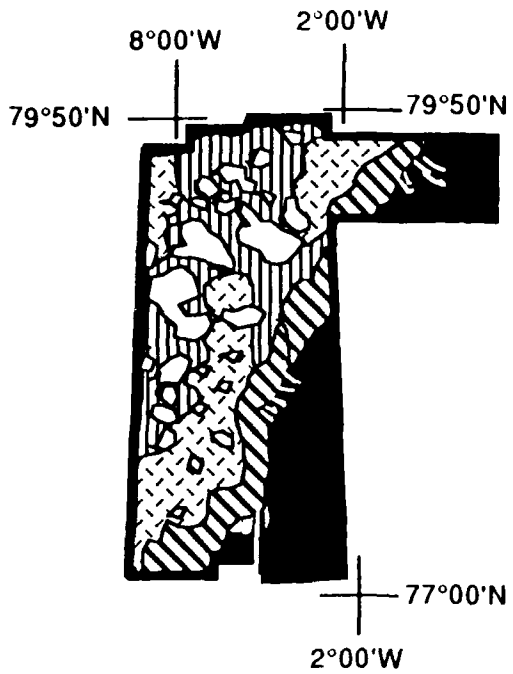


Figure 30. Ice Edge Location for 2 April 1987, Mission 8



50% Multi-Year Fragments, (1.5 - 3.5 m Thick), 50-250 m in Diameter in a First Year Ice Framework, (< 1 m Thick) 20-45% Total Ice Concentration

50-60% Multi-Year Floes, (1.5 - 4 m Thick) 50-250 m in Diameter Surrounded by First Year Ice, (< 1 m Thick) 70-90% Total Ice Concentration, Some Open Water Leads Exist

40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 31. Ice Concentration and Floe Size Interpretation for Mission 8

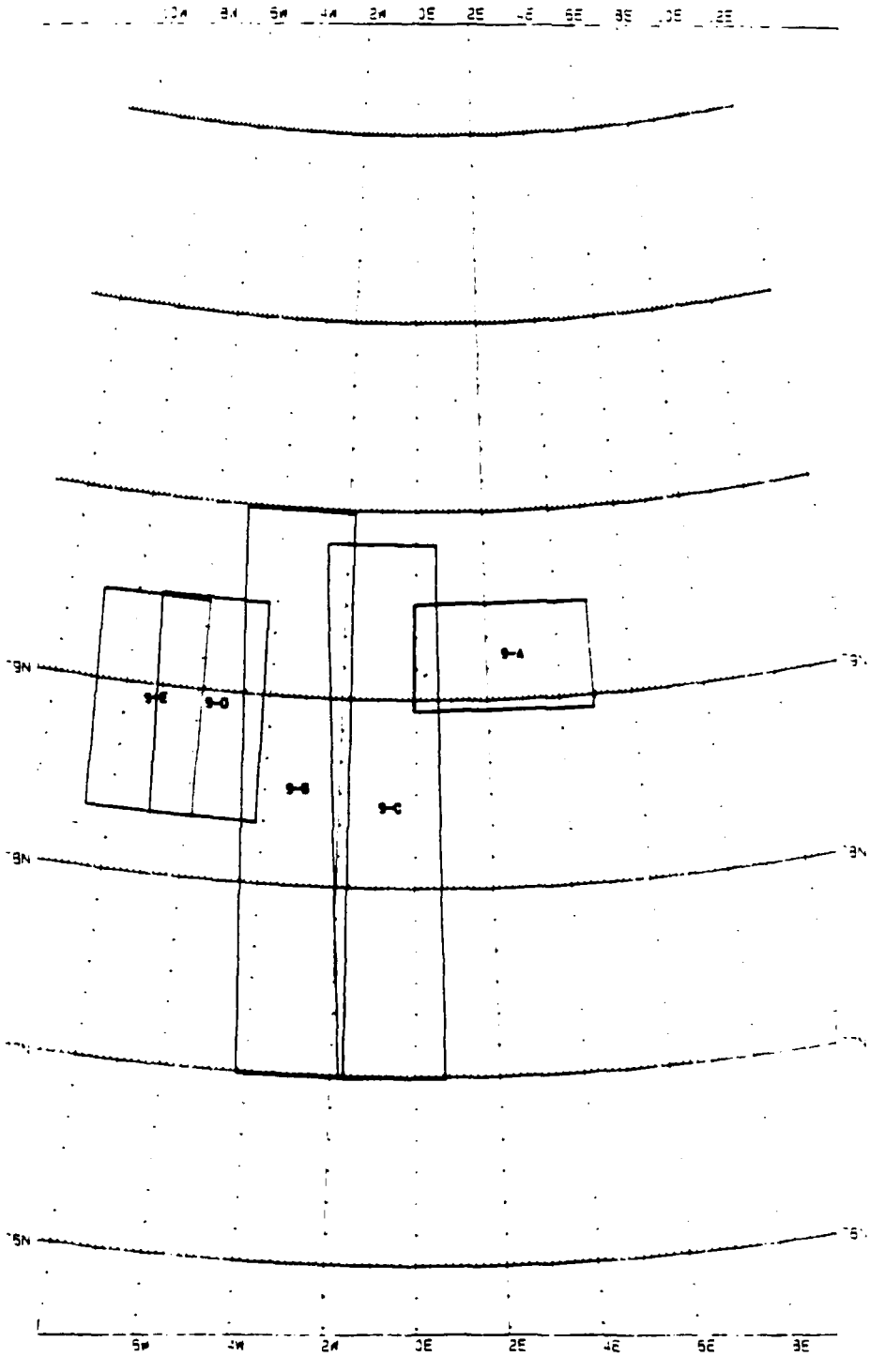


Figure 32. Area of SAR Coverage for MIZEX Mission 9, 2 April 1987

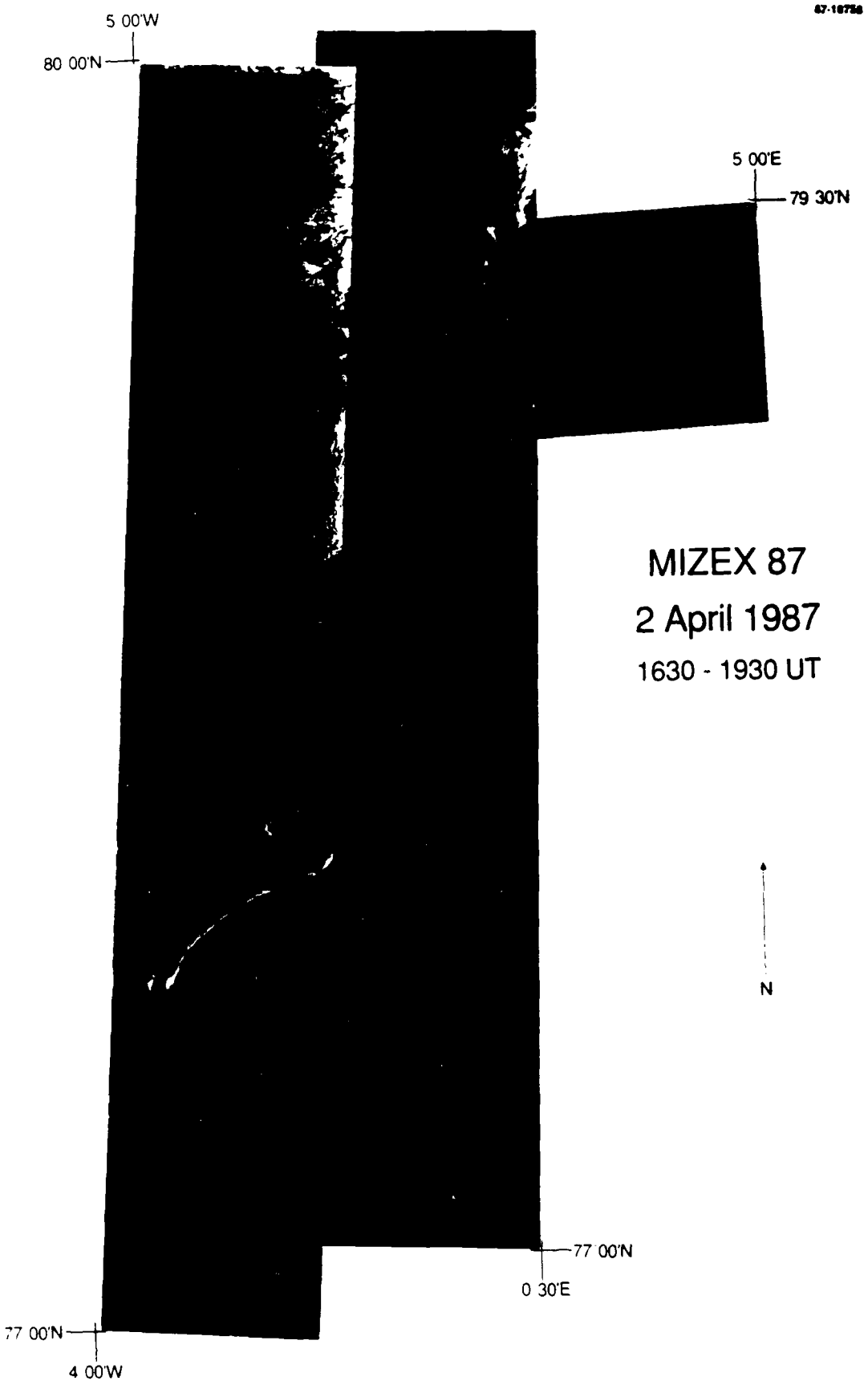


Figure 33. Mosaic of Real-Time Imagery for Mission 9

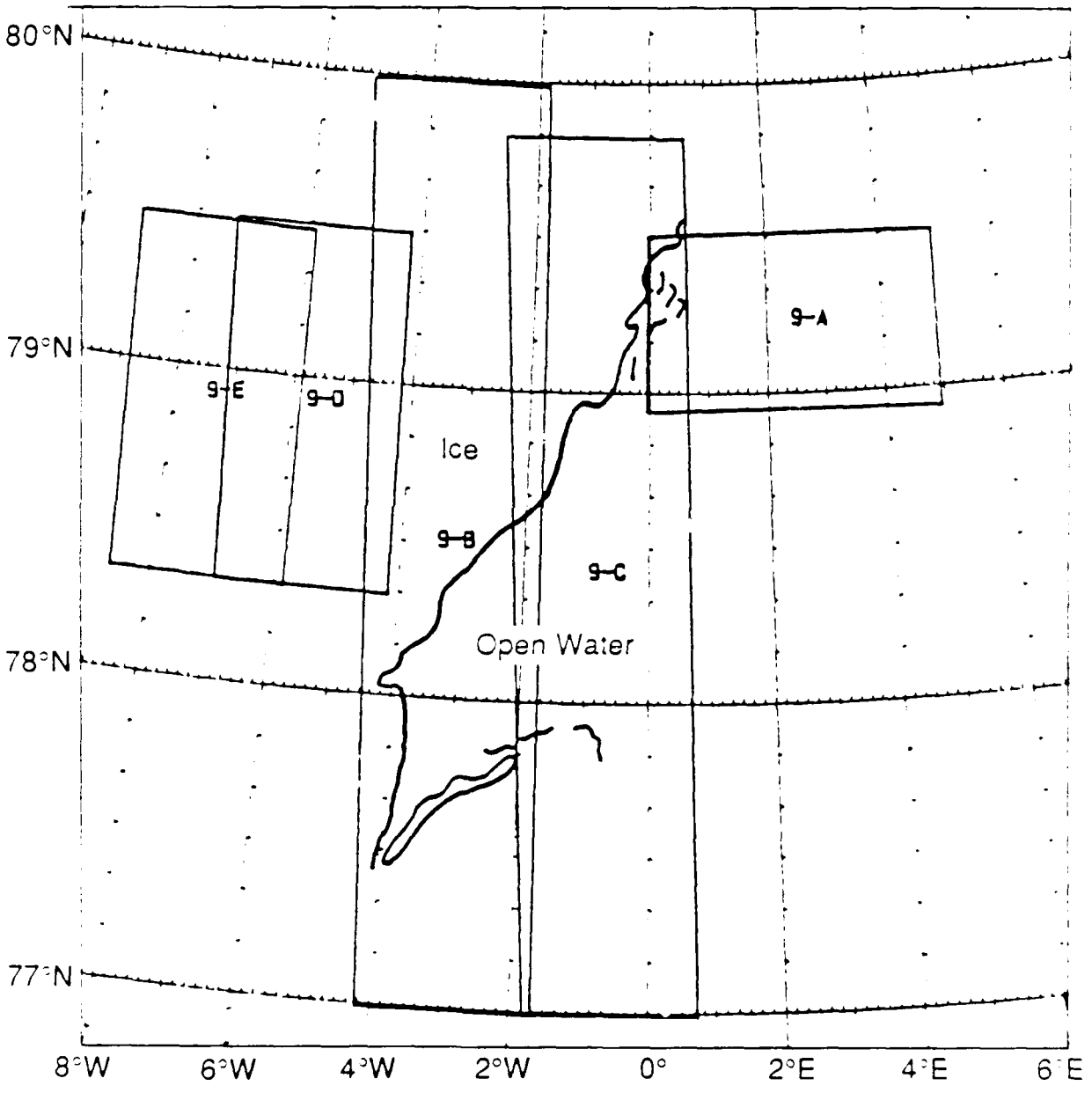


Figure 34. Ice Edge Location for 2 April 1987, Mission 9

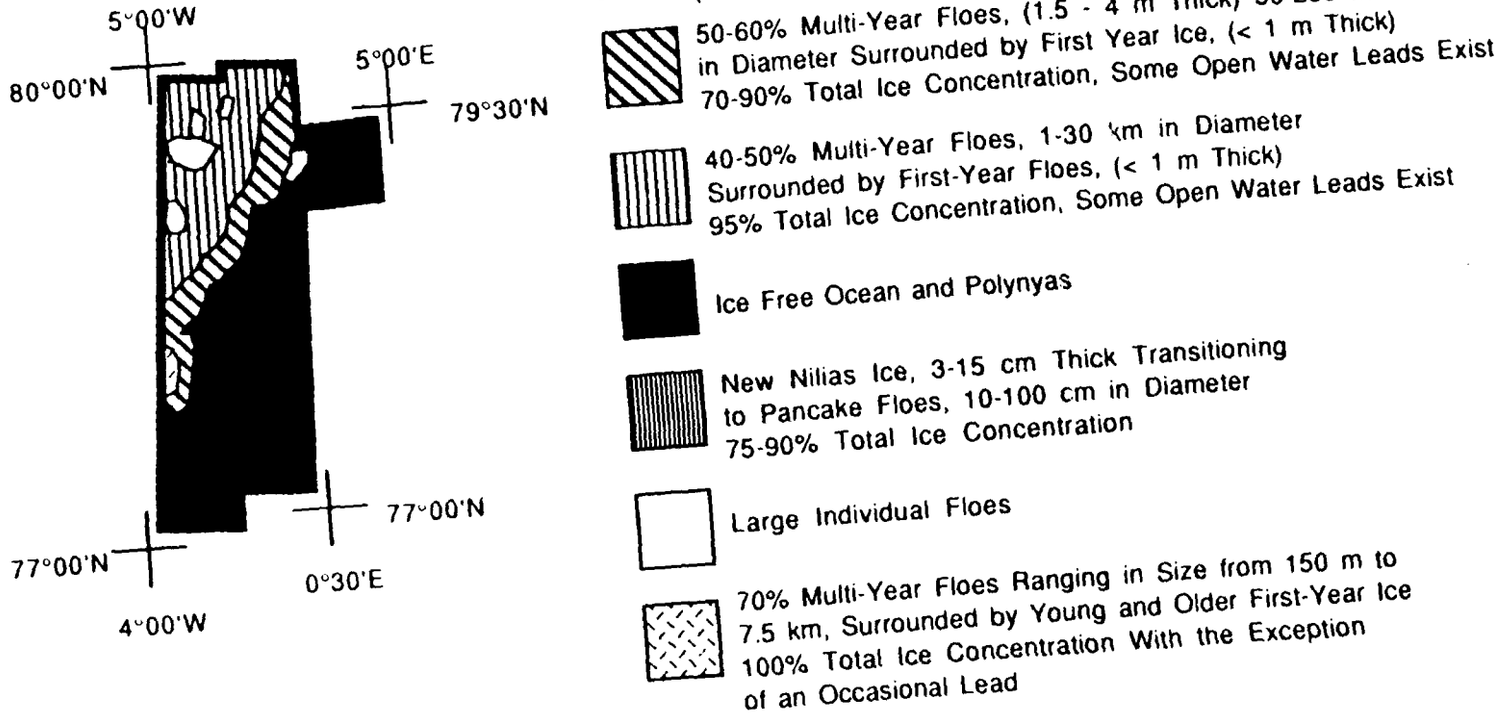


Figure 35. Ice Concentration and Floe Size Interpretation for Mission 9

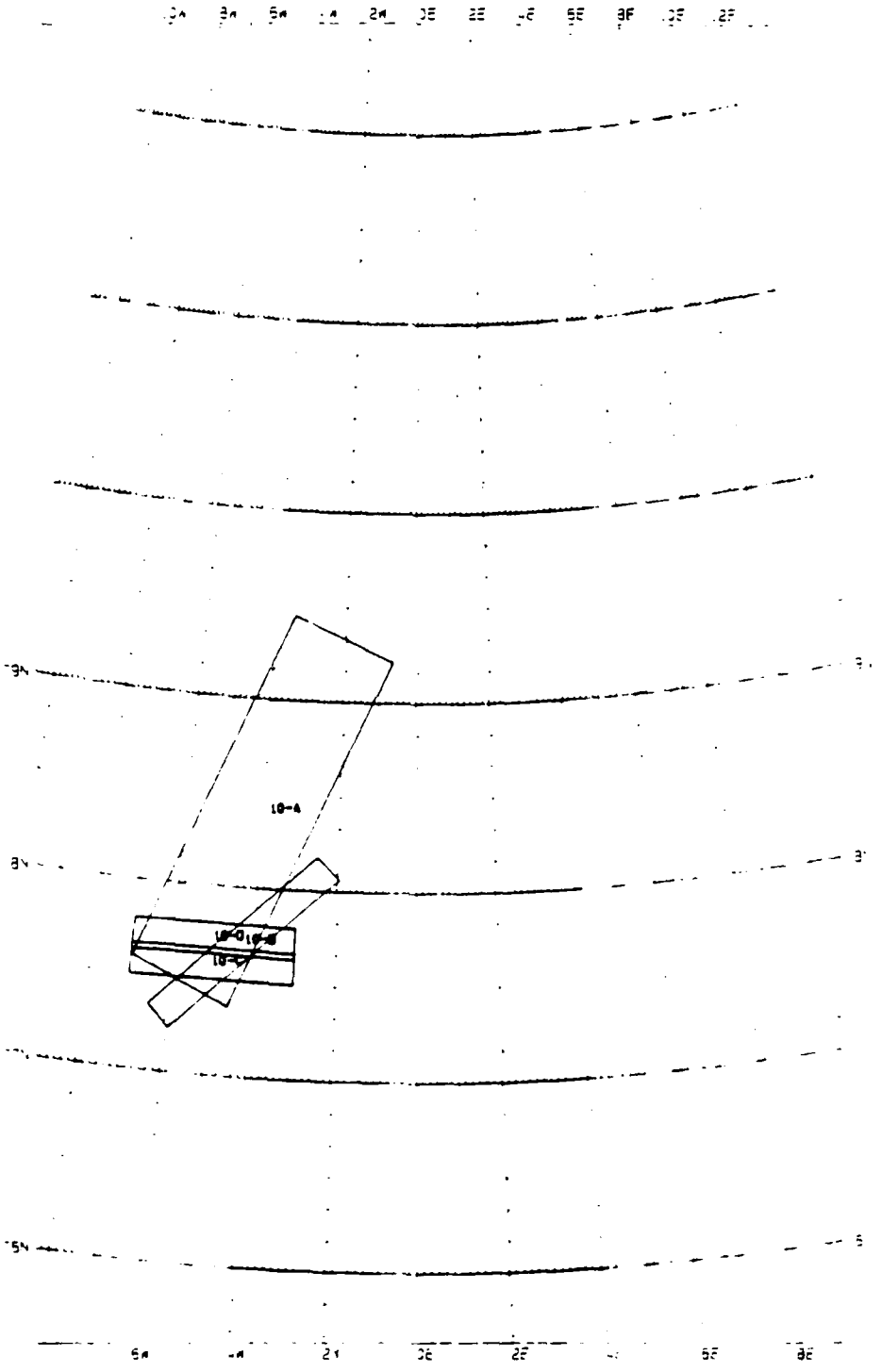


Figure 36. Area of SAR Coverage for MIZEX Mission 10, 3 April 1987

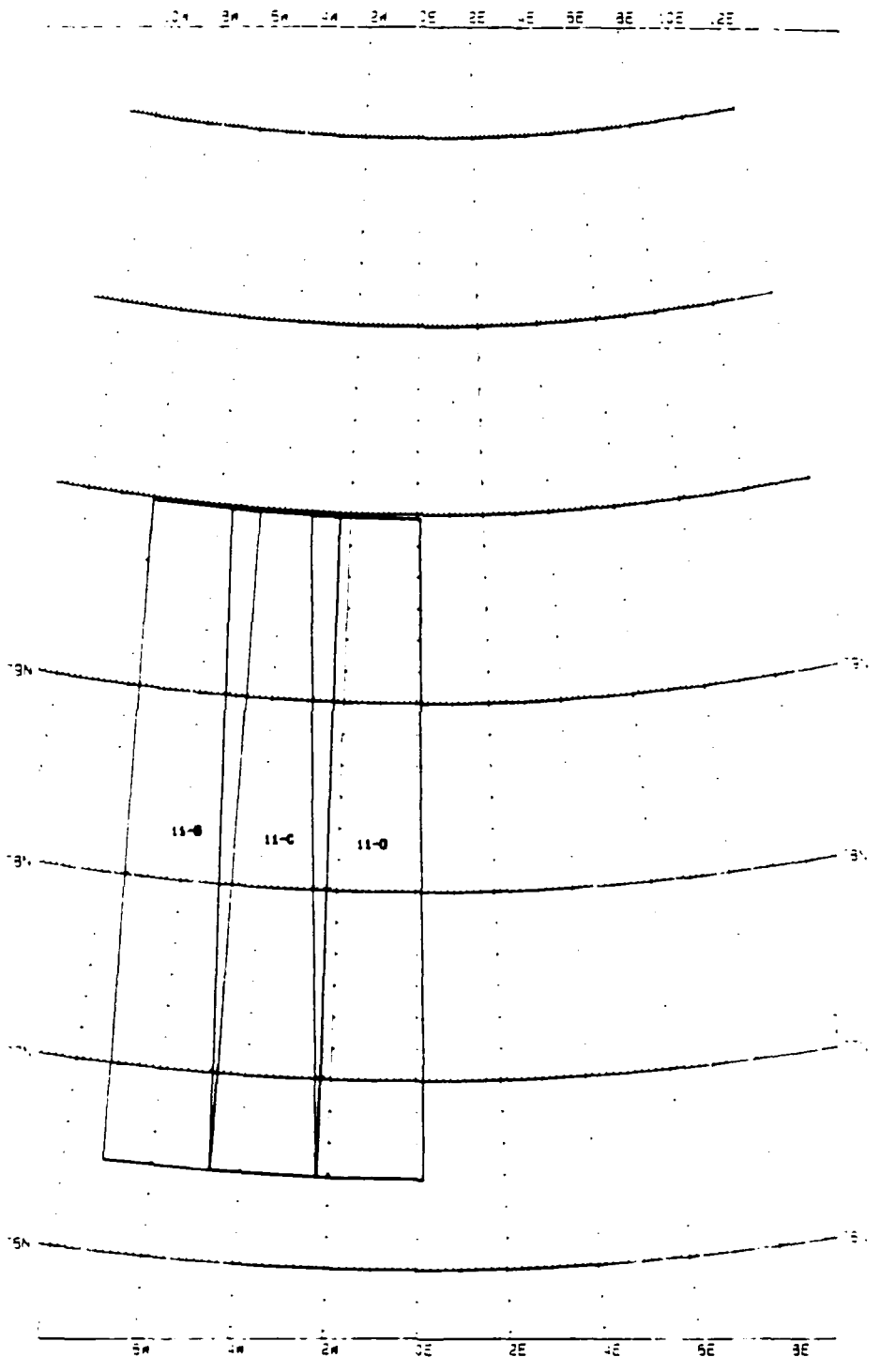


Figure 37. Area of SAR Coverage for MIZEX Mission 11, 3 April 1987

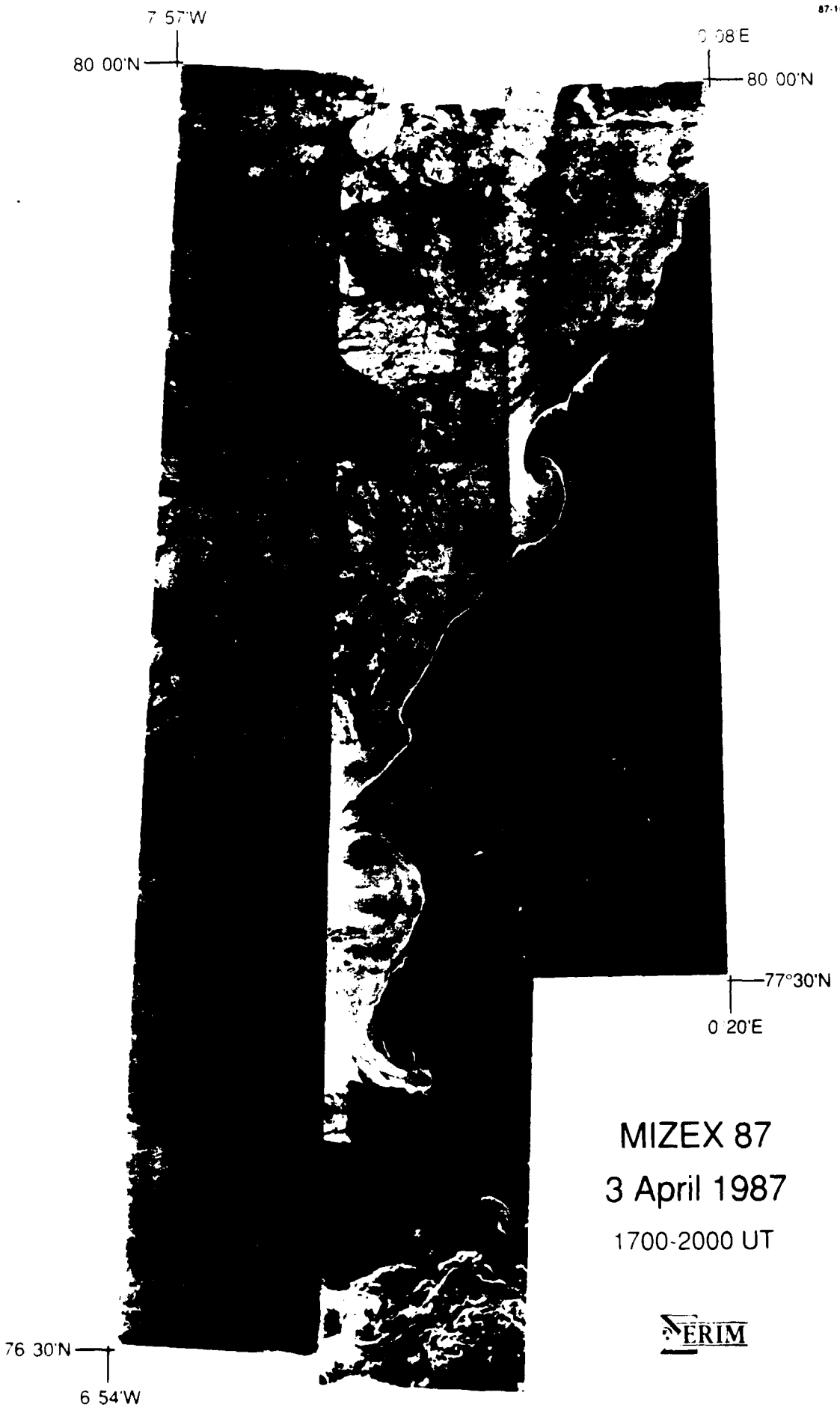


Figure 38. Mosaic of Real-Time Imagery for Mission 11

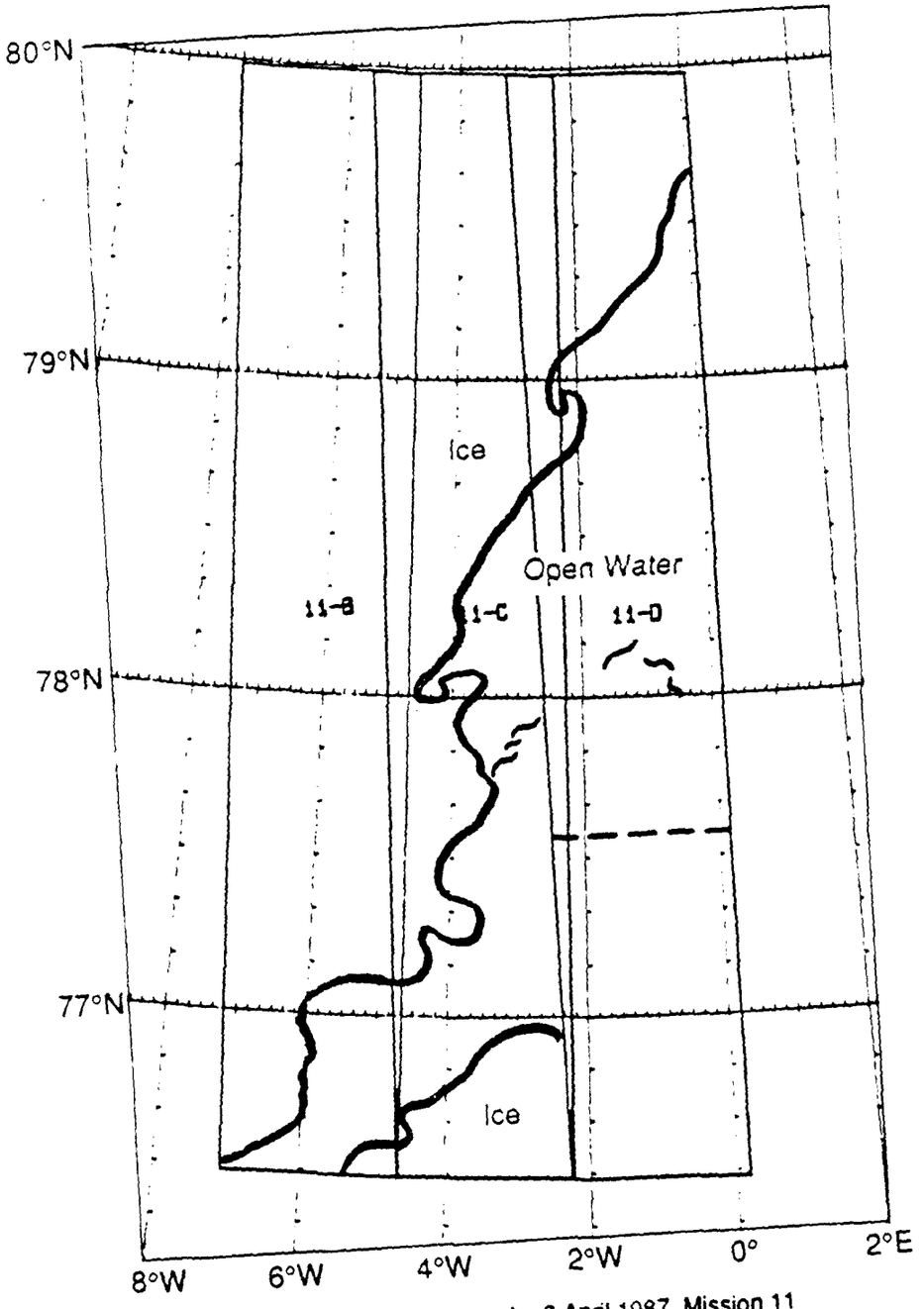
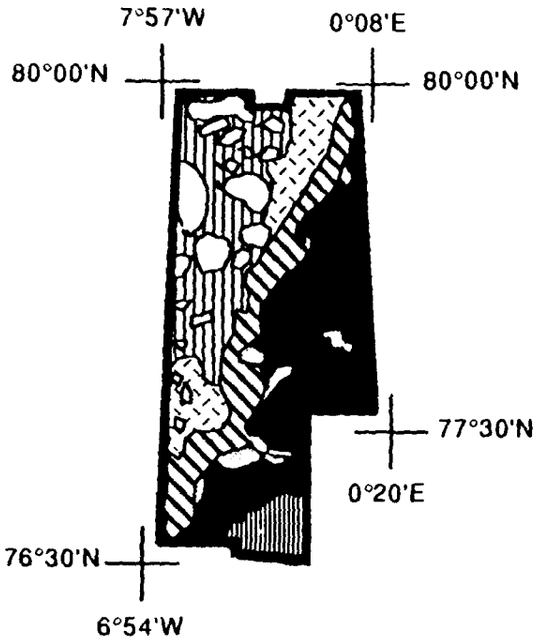


Figure 39. Ice Edge Location for 3 April 1987, Mission 11



50% Multi-Year Fragments, (1.5 - 3.5 m Thick), 50-250 m in Diameter in a First Year Ice Framework, (< 1 m Thick) 20-45% Total Ice Concentration

50-60% Multi-Year Floes, (1.5 - 4 m Thick) 50-250 m in Diameter Surrounded by First Year Ice, (< 1 m Thick) 70-90% Total Ice Concentration, Some Open Water Leads Exist

40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 40. Ice Concentration and Floe Size Interpretation for Mission 11

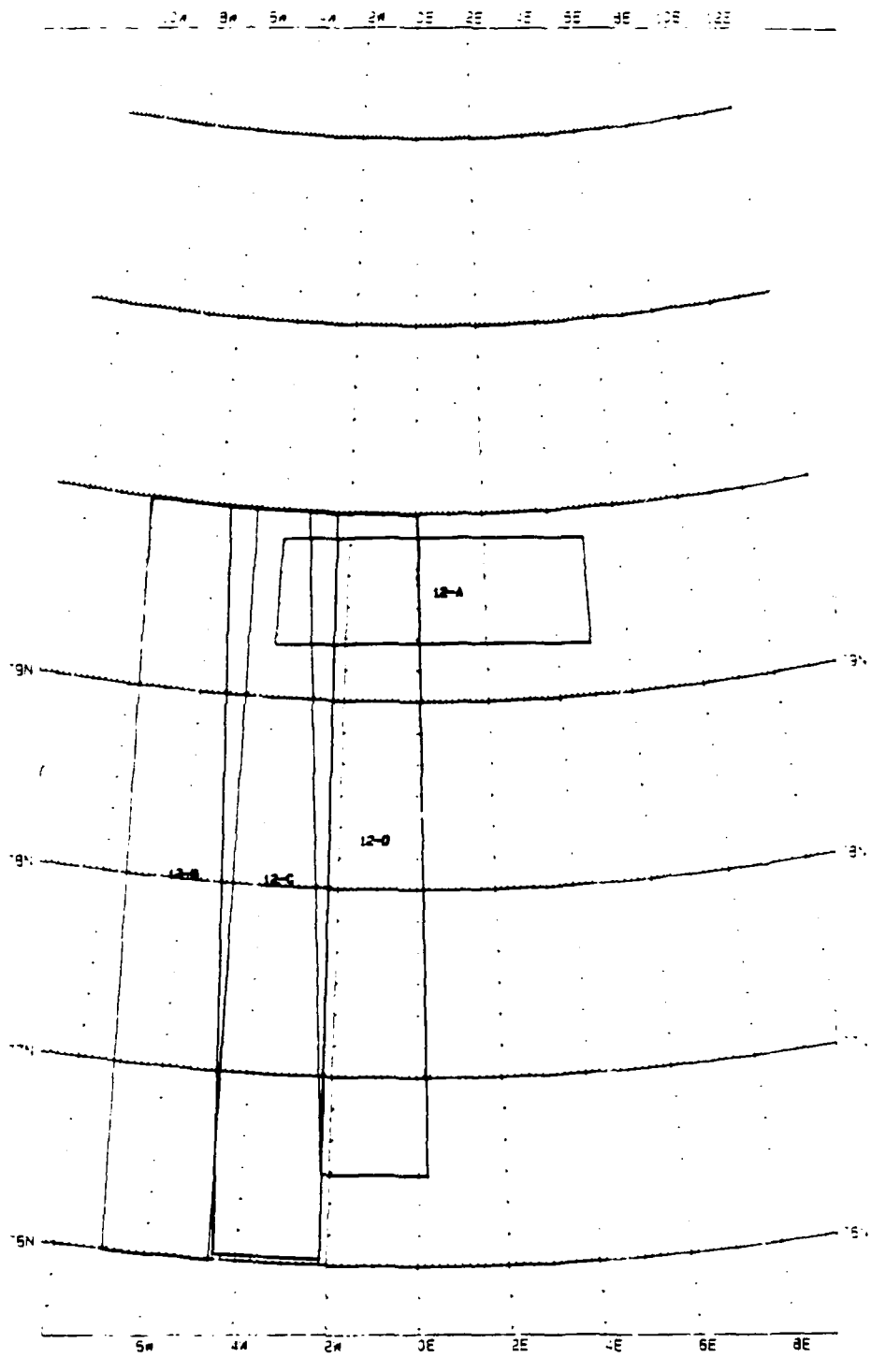


Figure 41. Area of SAR Coverage for MIZEX Mission 12, 4 April 1987

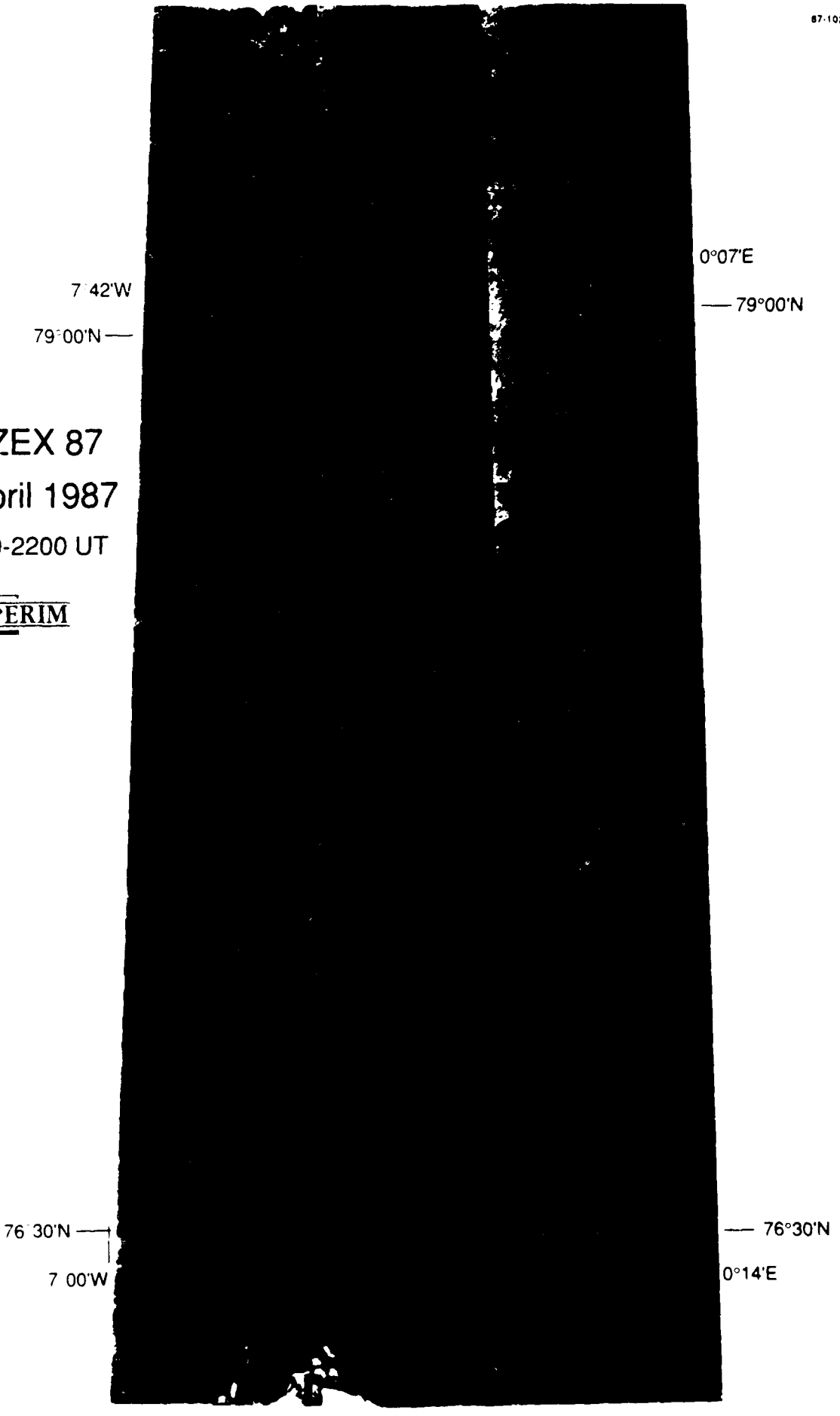


Figure 42. Mosaic of Real-Time Imagery for Mission 12

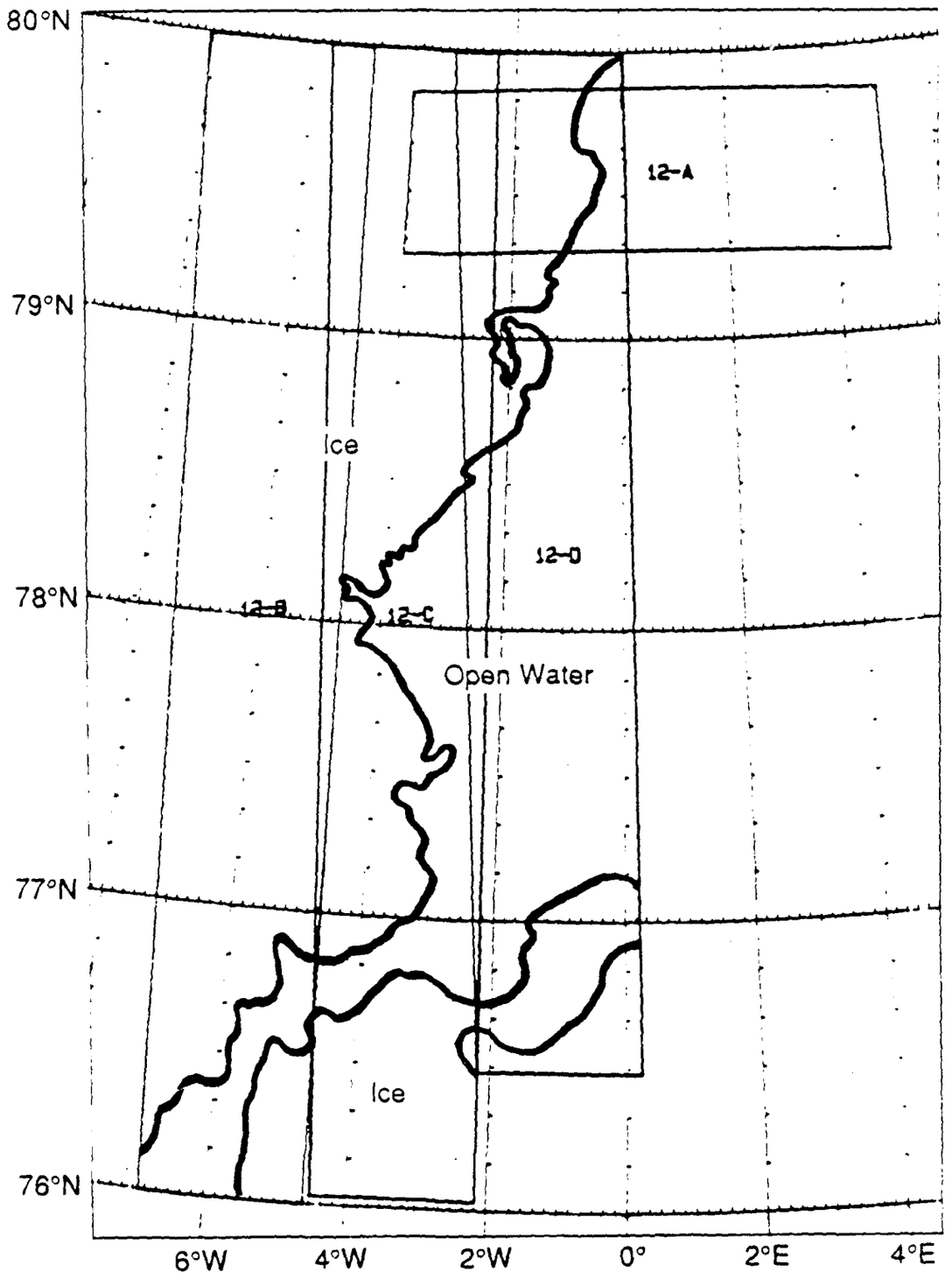


Figure 43. Ice Edge Location for 4 April 1987, Mission 12

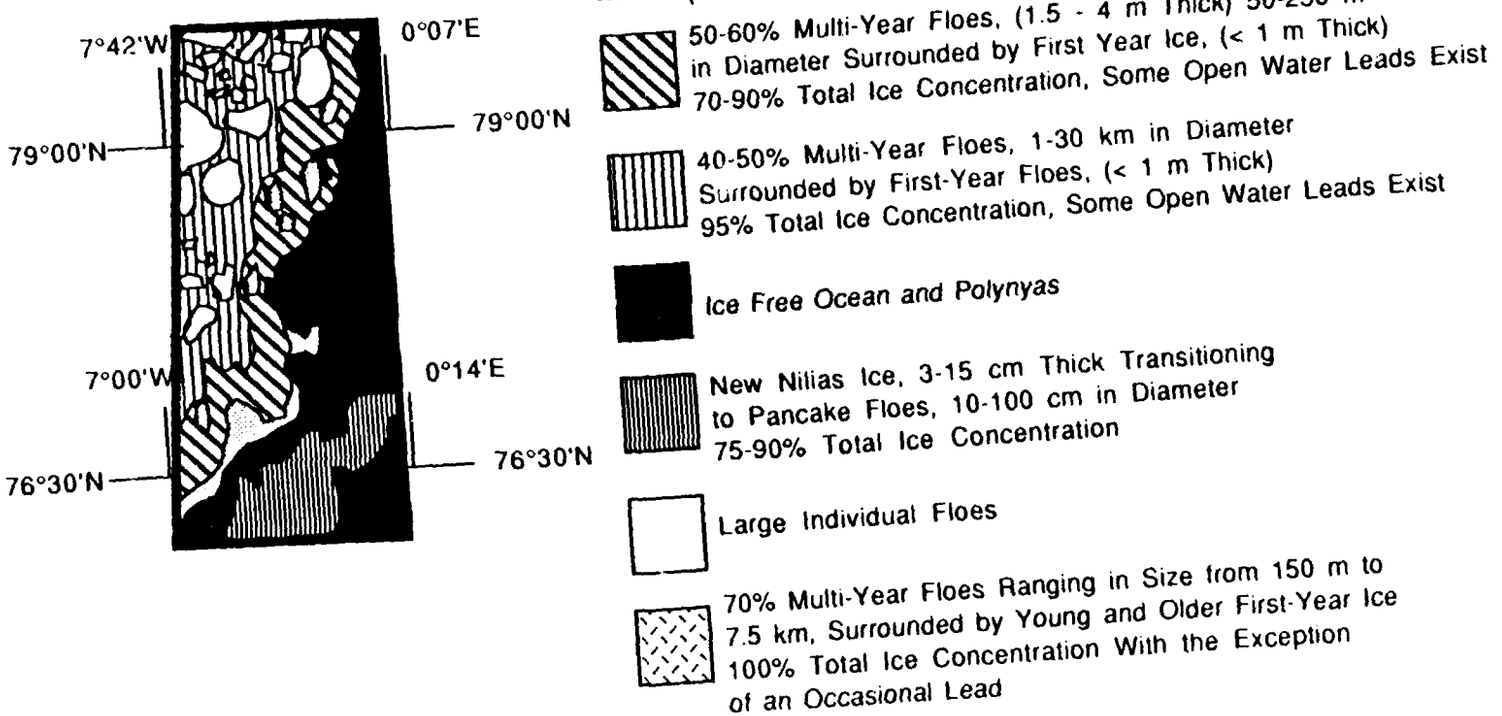


Figure 44. Ice Concentration and Floe Size Interpretation for Mission 12

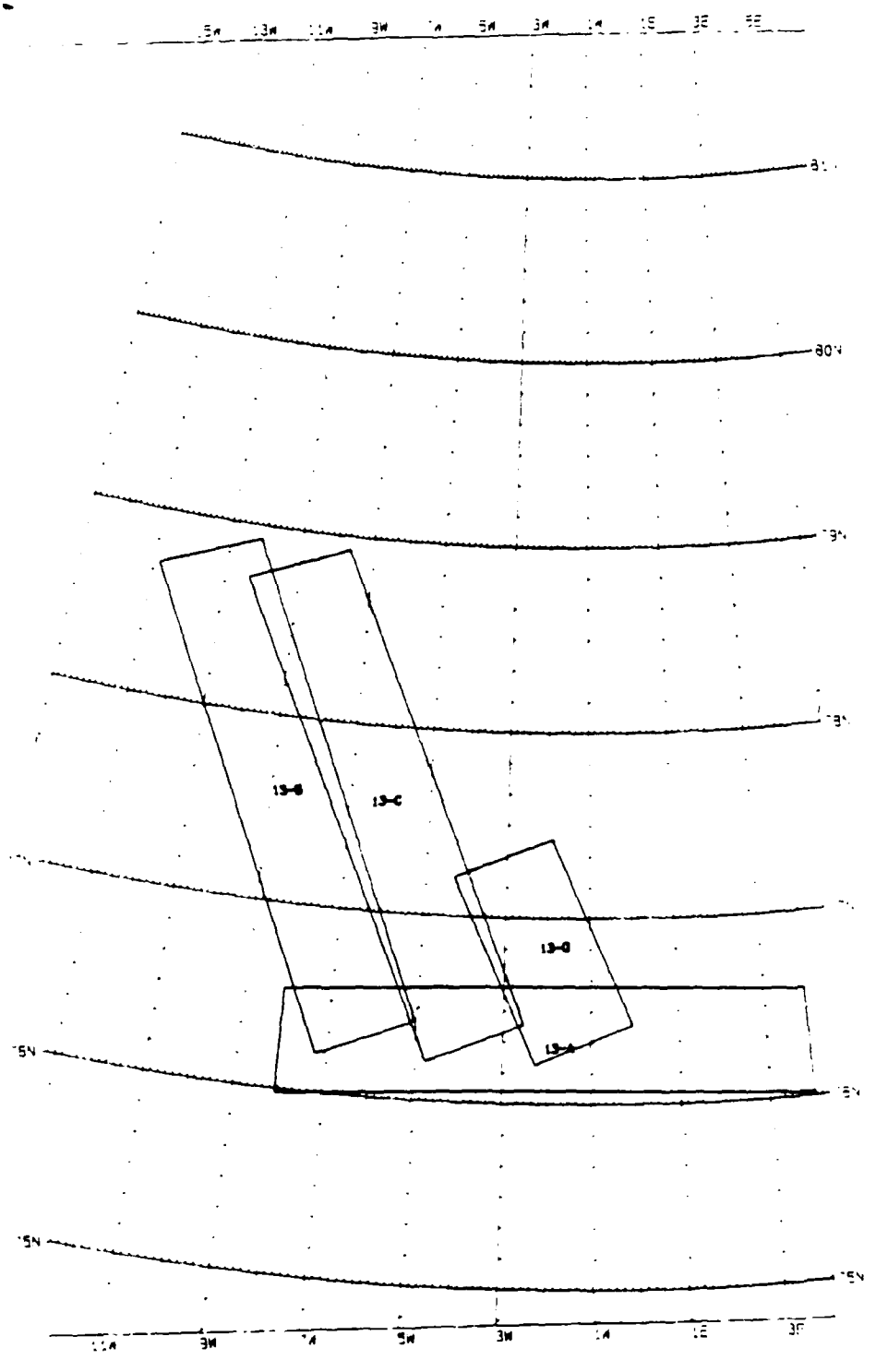


Figure 45. Area of SAR Coverage for MIZEX Mission 13, 5 April 1987

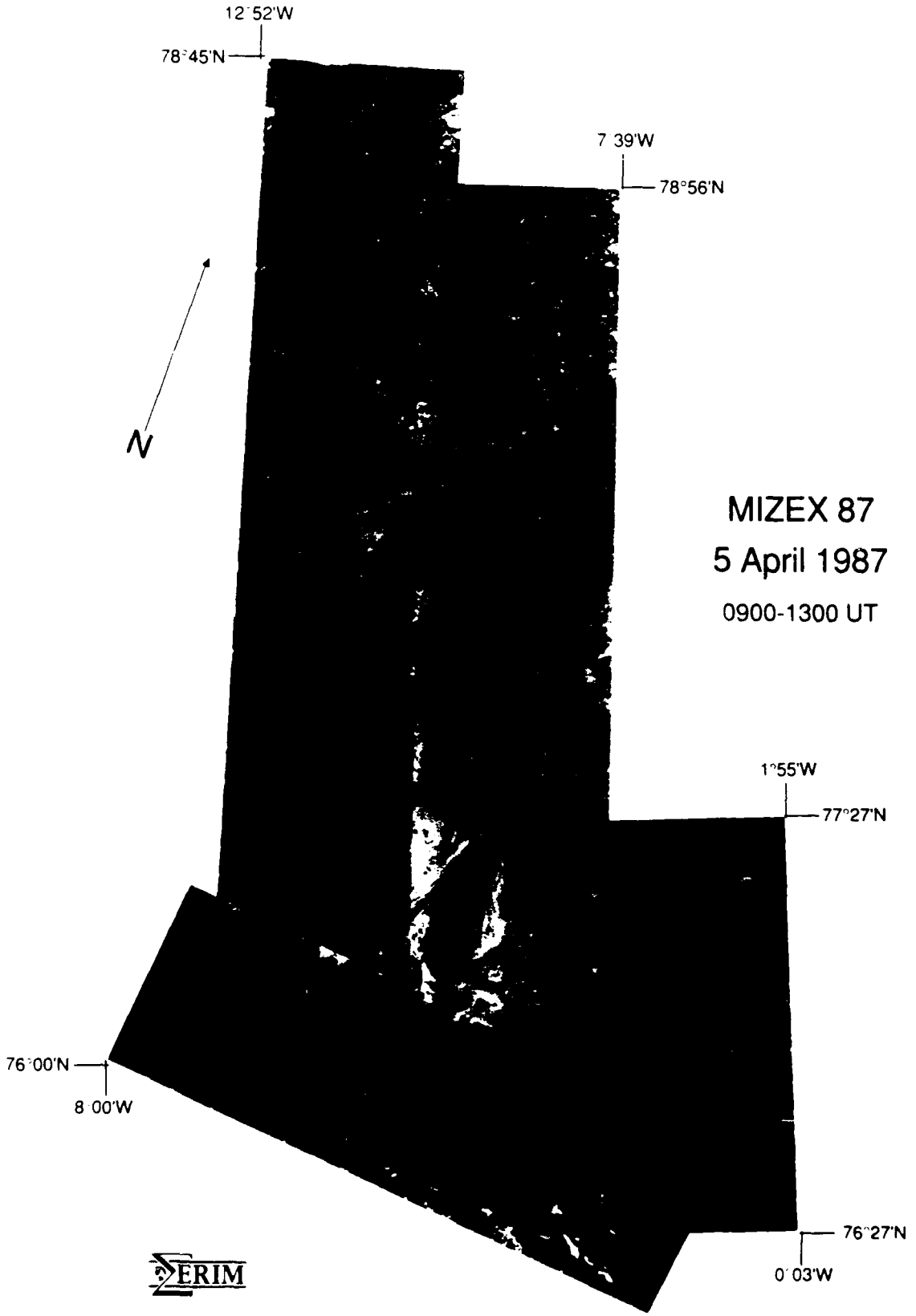


Figure 46. Mosaic of Real-Time Imagery for Mission 13

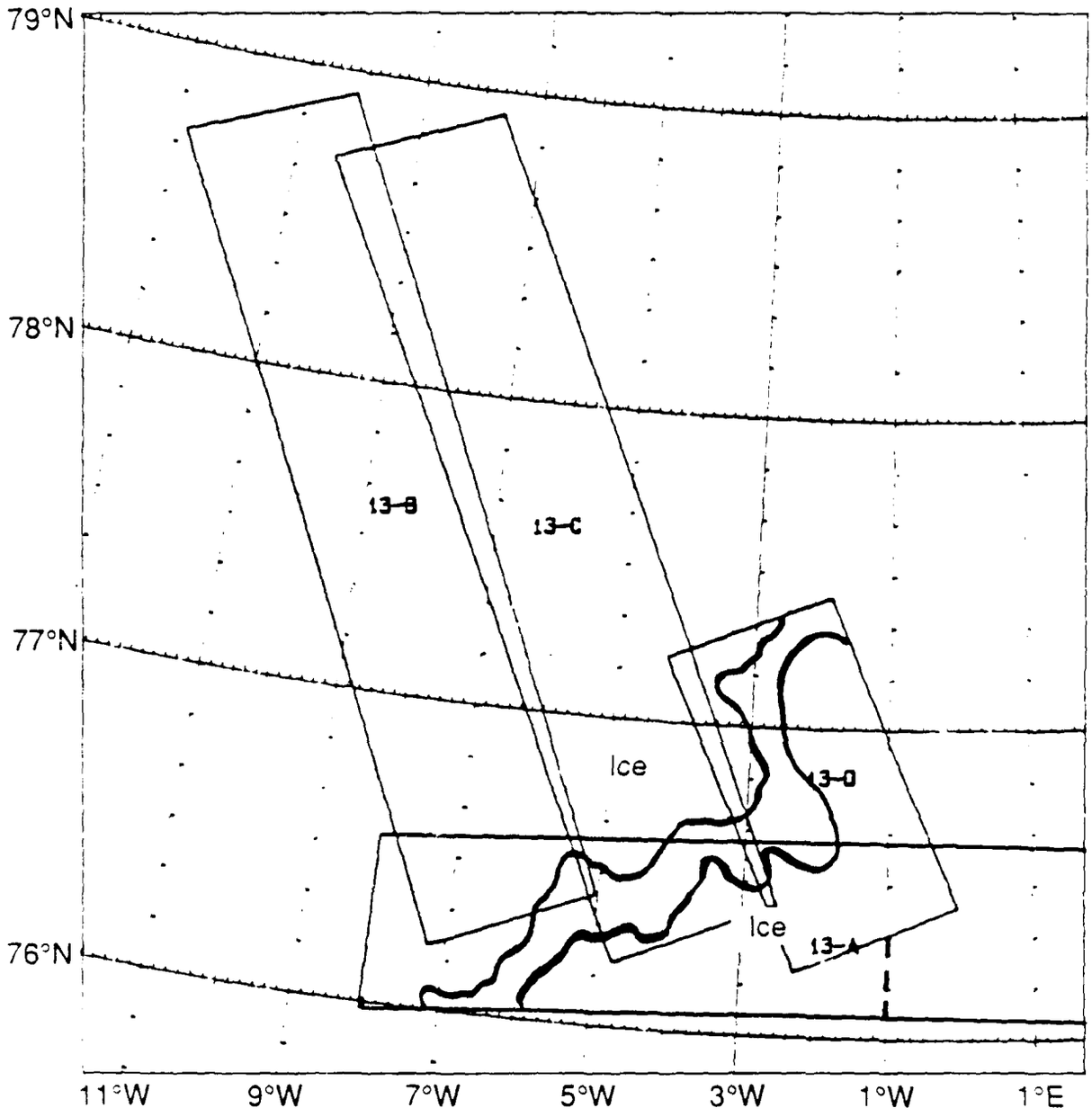
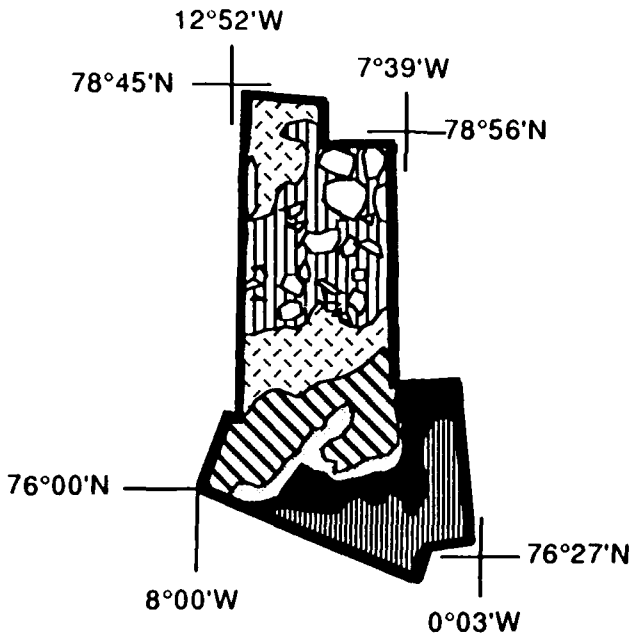


Figure 47. Ice Edge Location for 5 April 1987, Mission 13



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40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 48. Ice Concentration and Floe Size Interpretation for Mission 13

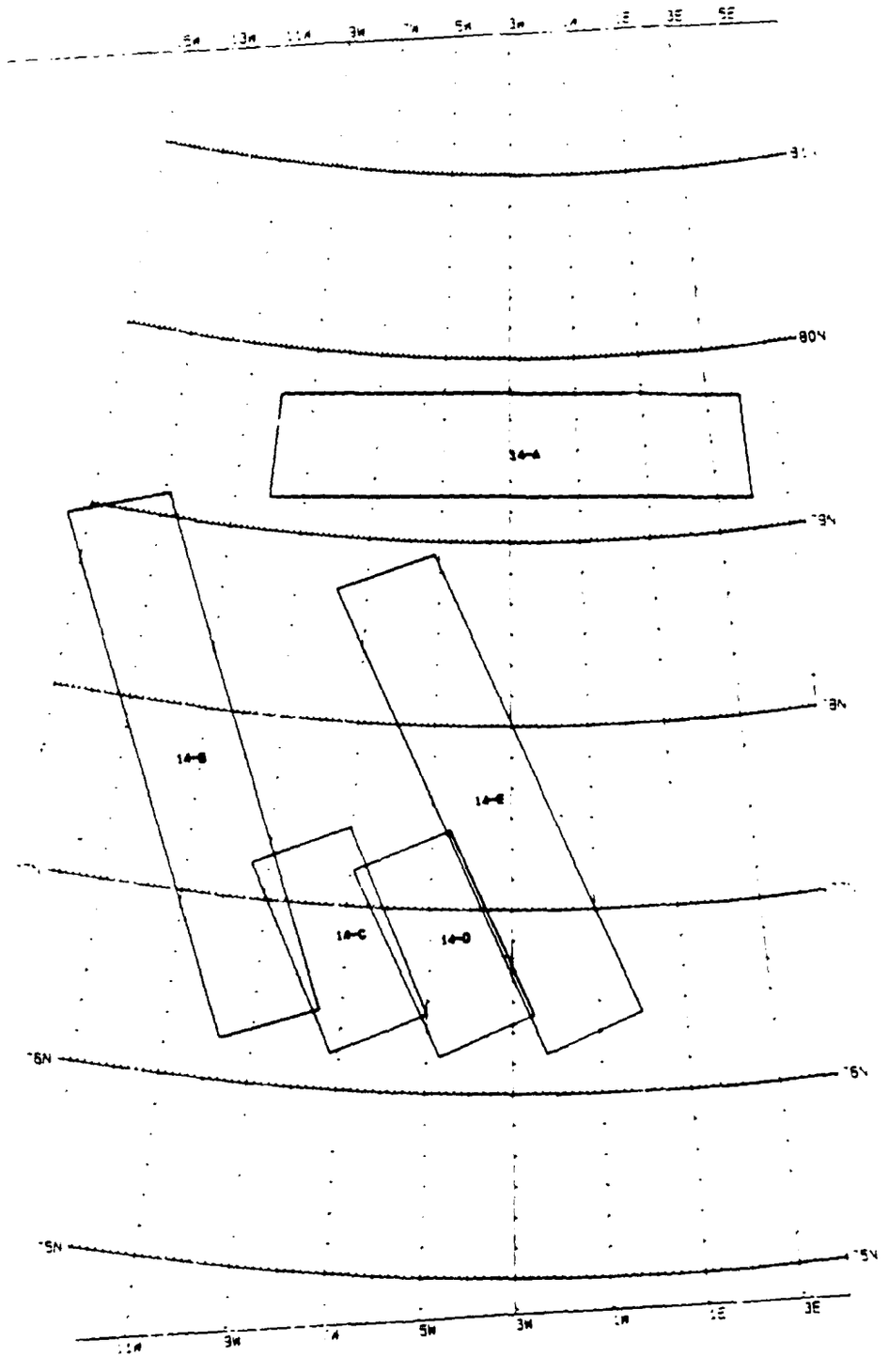


Figure 49. Area of SAR Coverage for MIZEX Mission 14, 5 April 1987

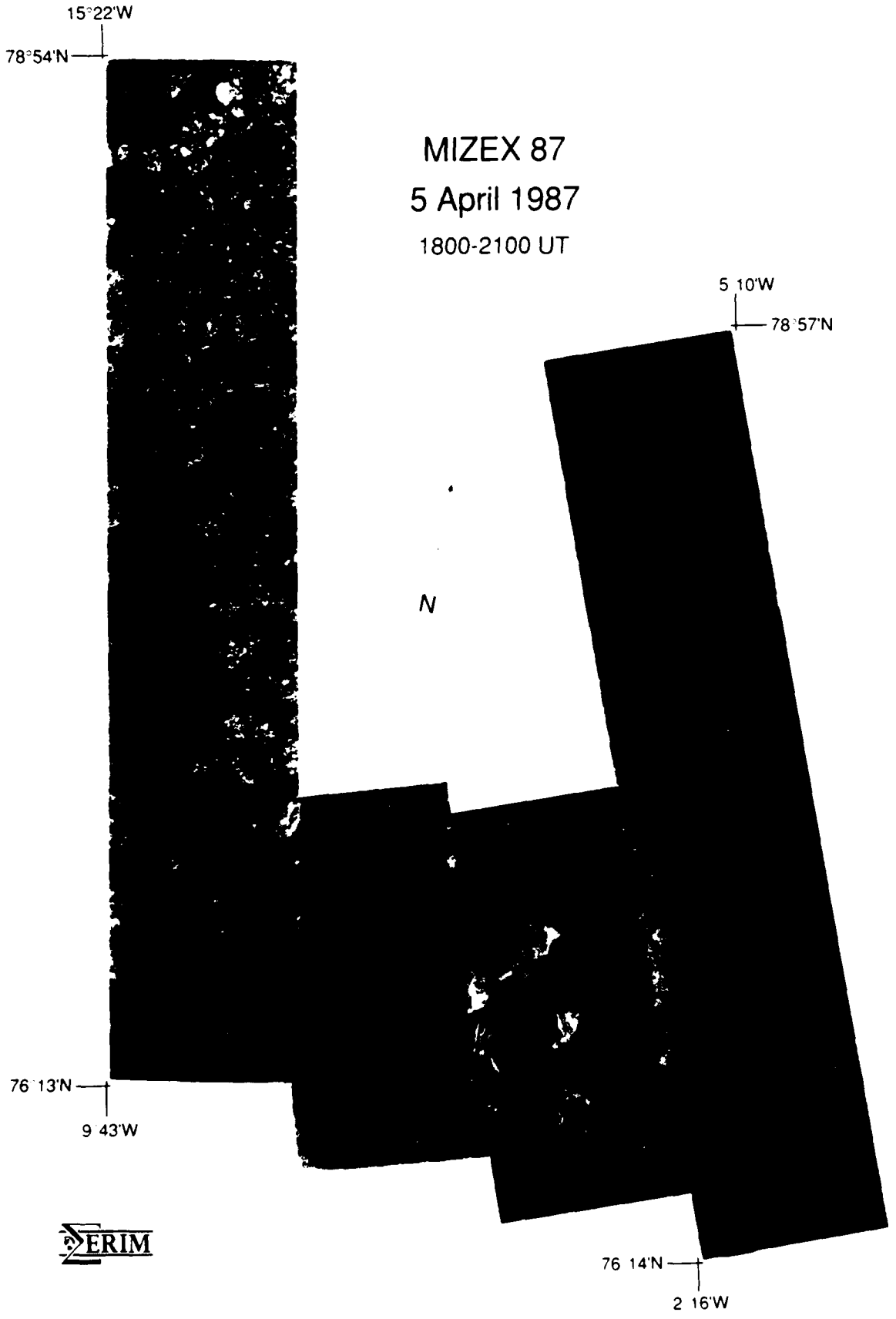


Figure 50. Mosaic of Real-Time Imagery for Mission 14

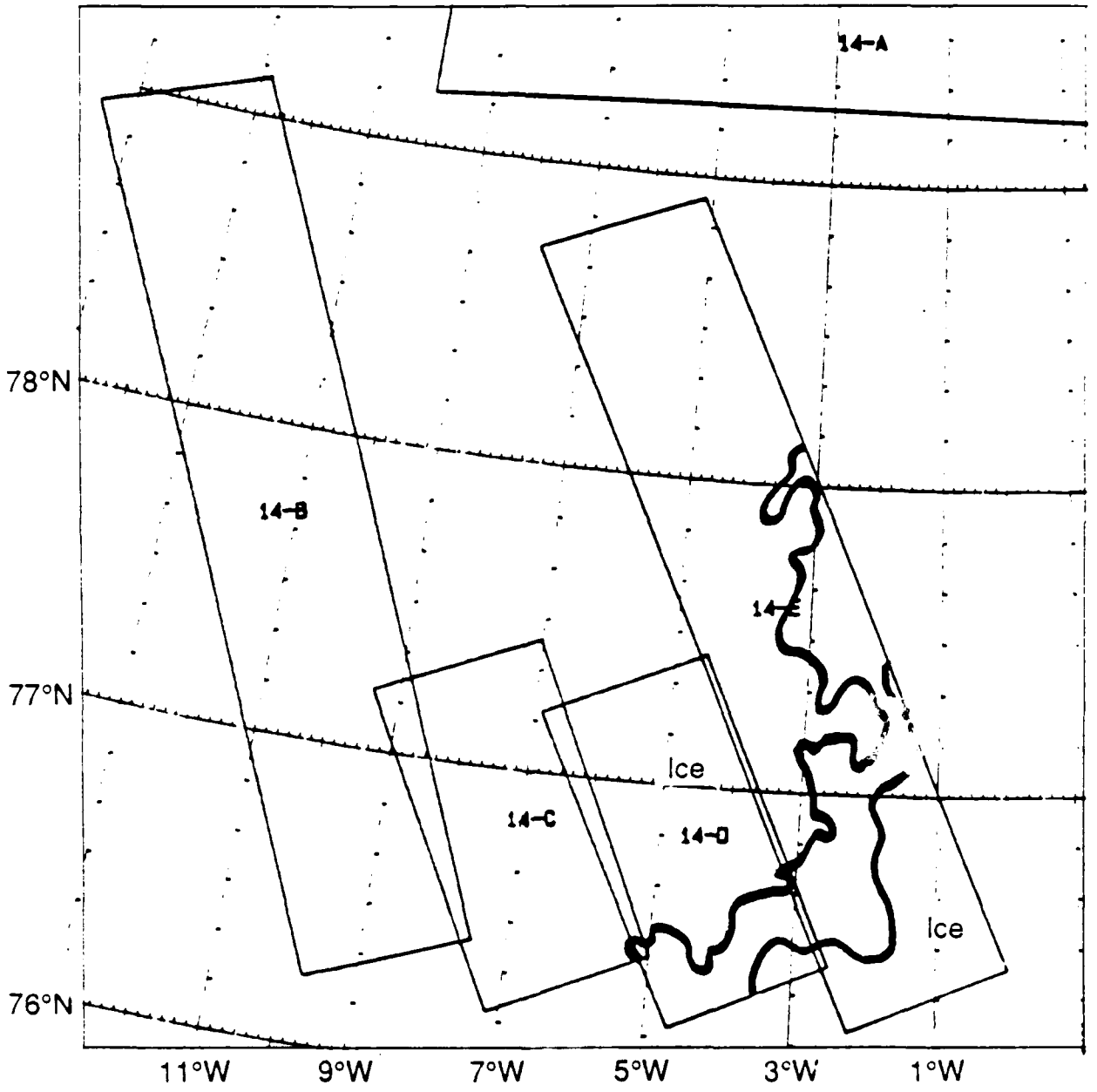


Figure 51. Ice Edge Location for 5 April 1987, Mission 14

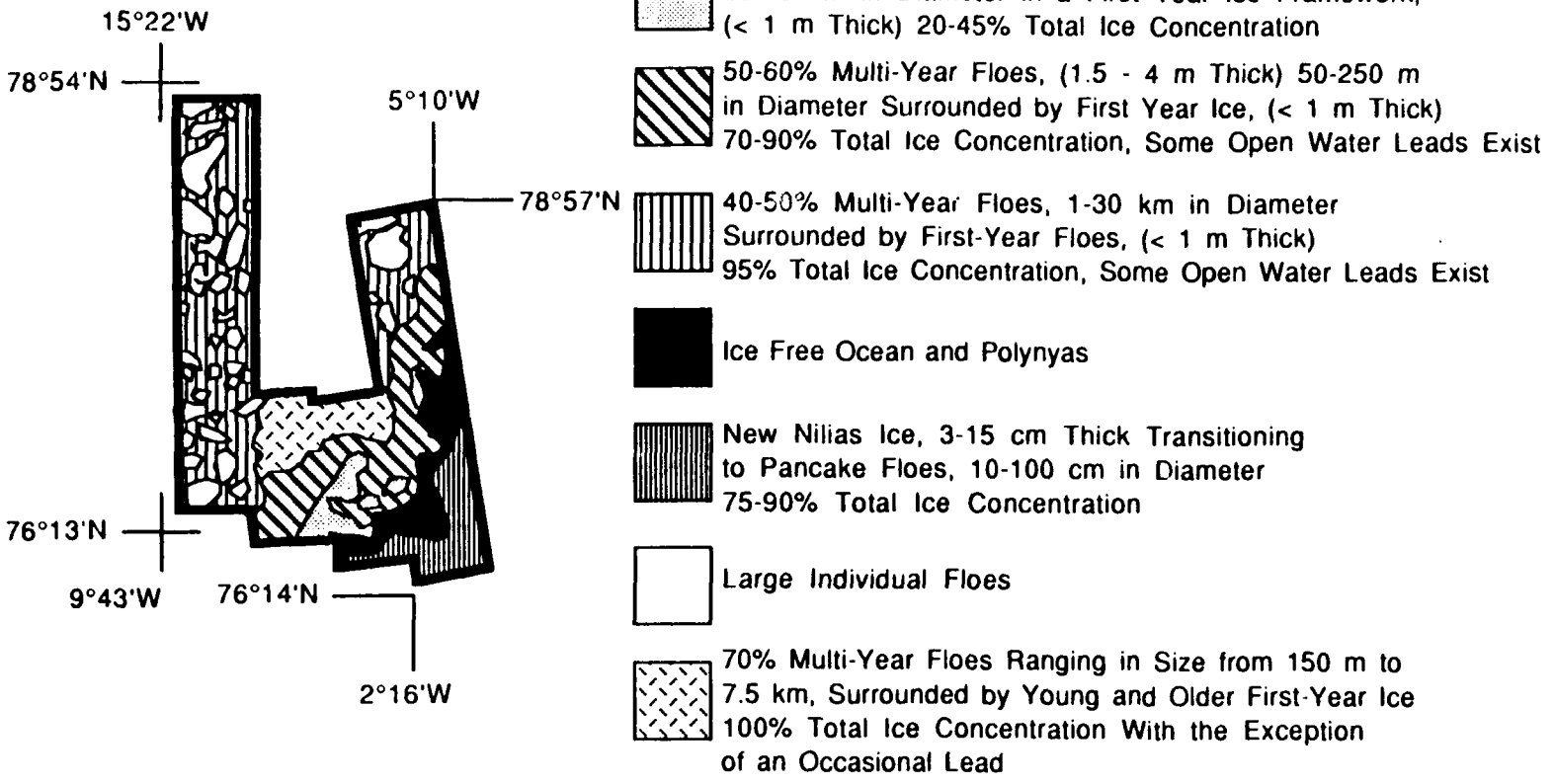


Figure 52. Ice Concentration and Floe Size Interpretation for Mission 14

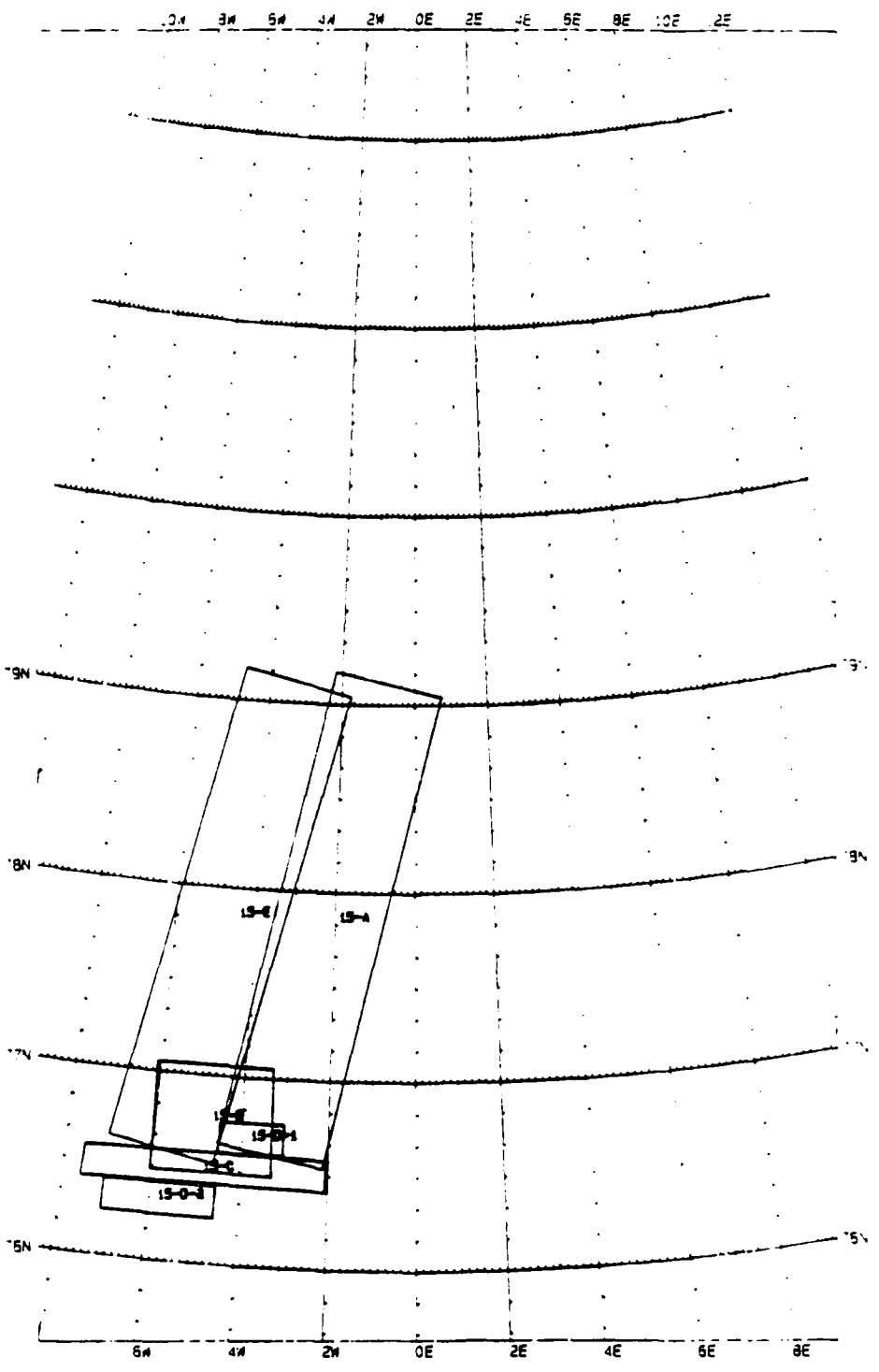


Figure 53. Area of SAR Coverage for MIZEX Mission 15, 6 April 1987

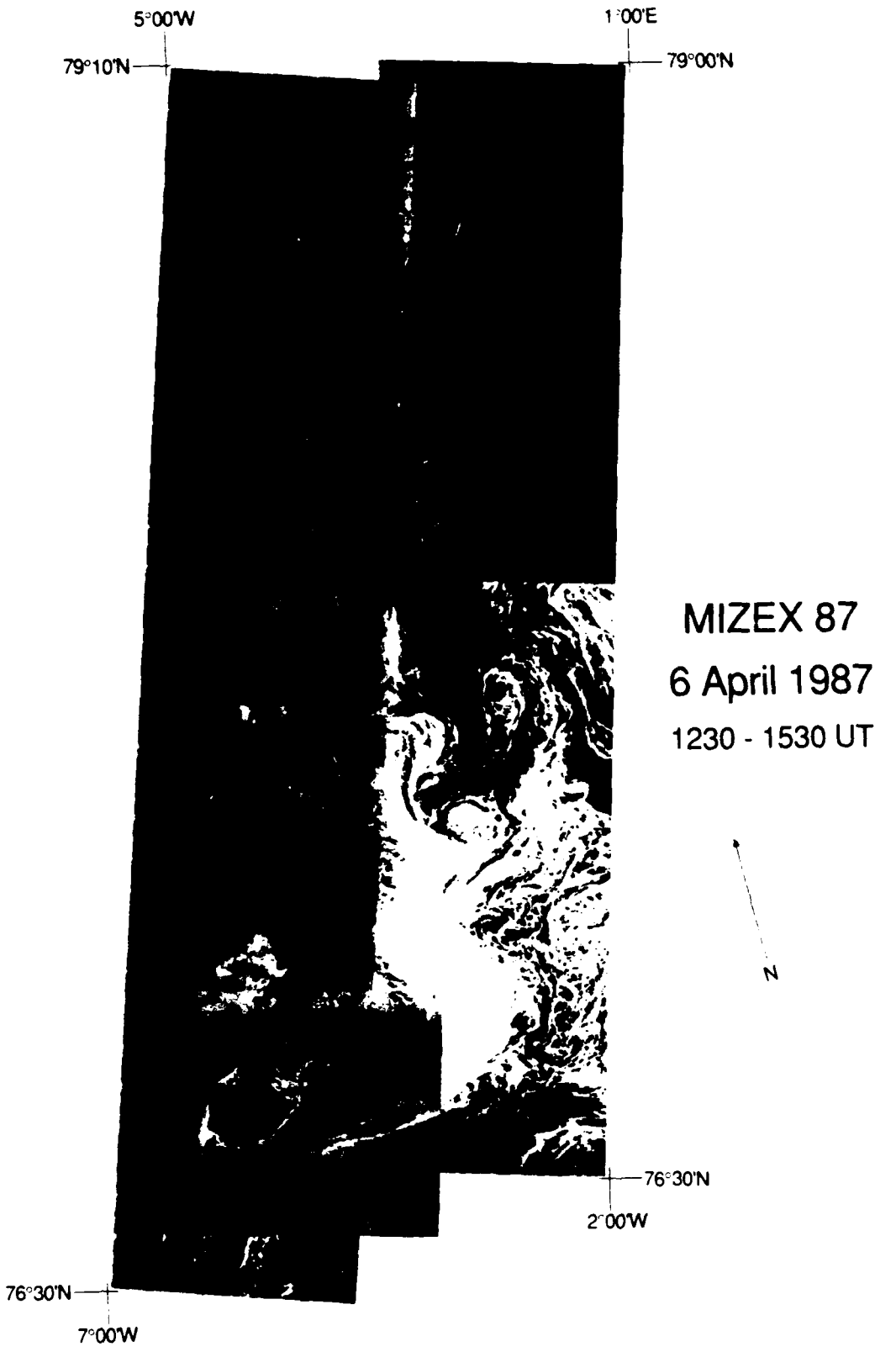


Figure 54. Mosaic of Real-Time Imagery for Mission 15

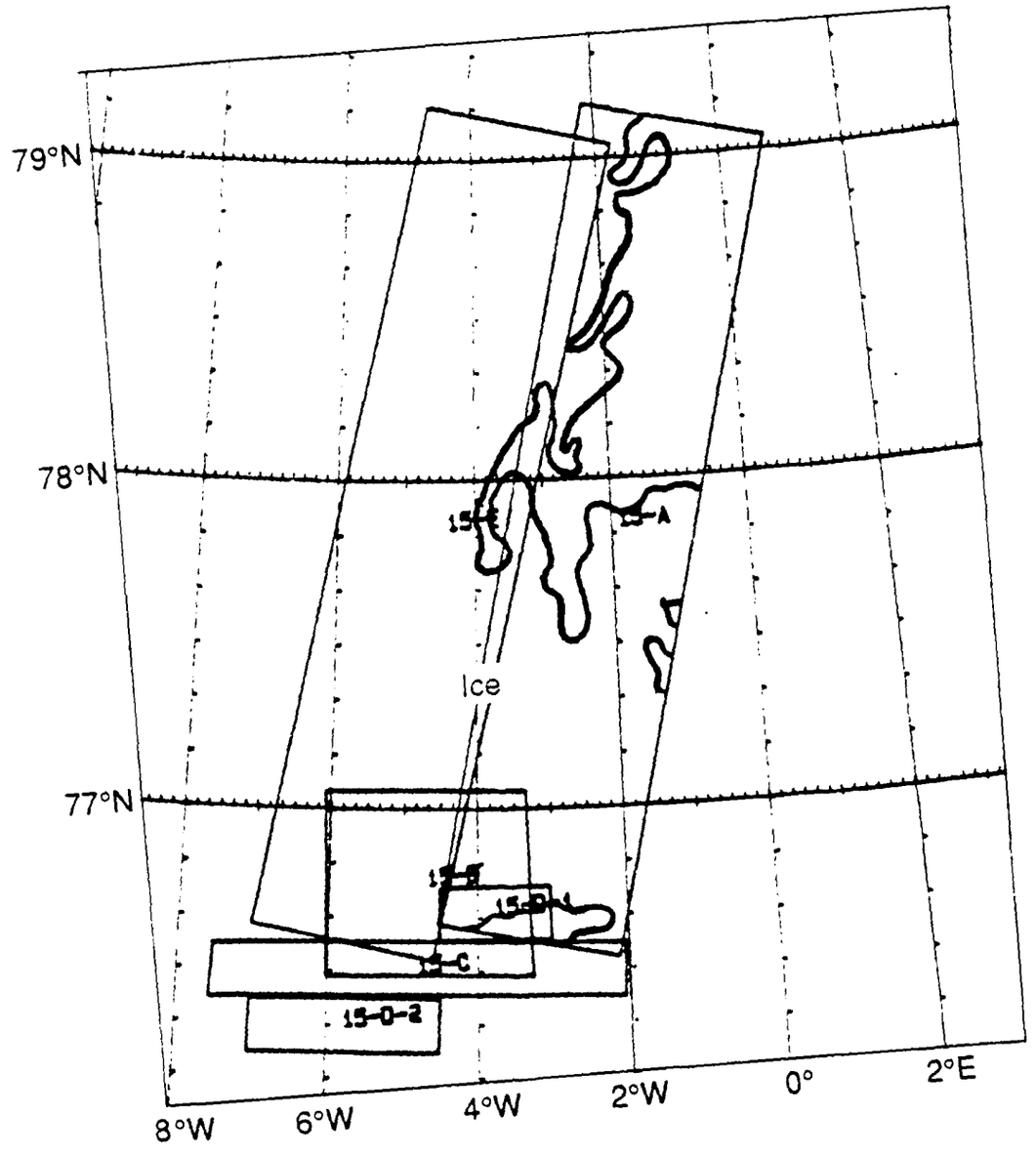
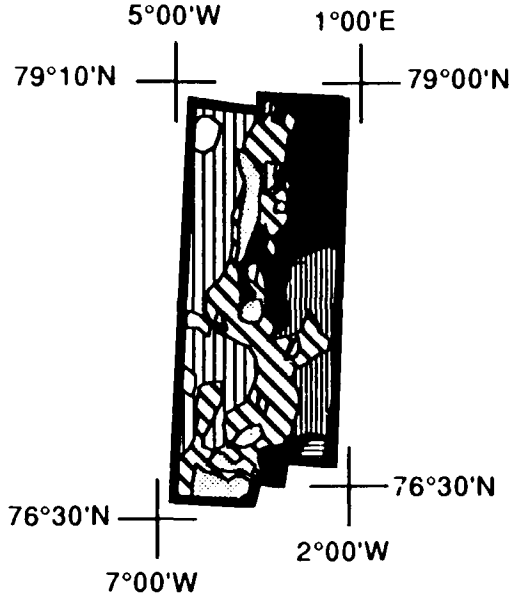


Figure 55. Ice Edge Location for 6 April 1987, Mission 15



50% Multi-Year Fragments, (1.5 - 3.5 m Thick), 50-250 m in Diameter in a First Year Ice Framework, (< 1 m Thick) 20-45% Total Ice Concentration

50-60% Multi-Year Floes, (1.5 - 4 m Thick) 50-250 m in Diameter Surrounded by First Year Ice, (< 1 m Thick) 70-90% Total Ice Concentration, Some Open Water Leads Exist

40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 56. Ice Concentration and Floe Size Interpretation for Mission 15

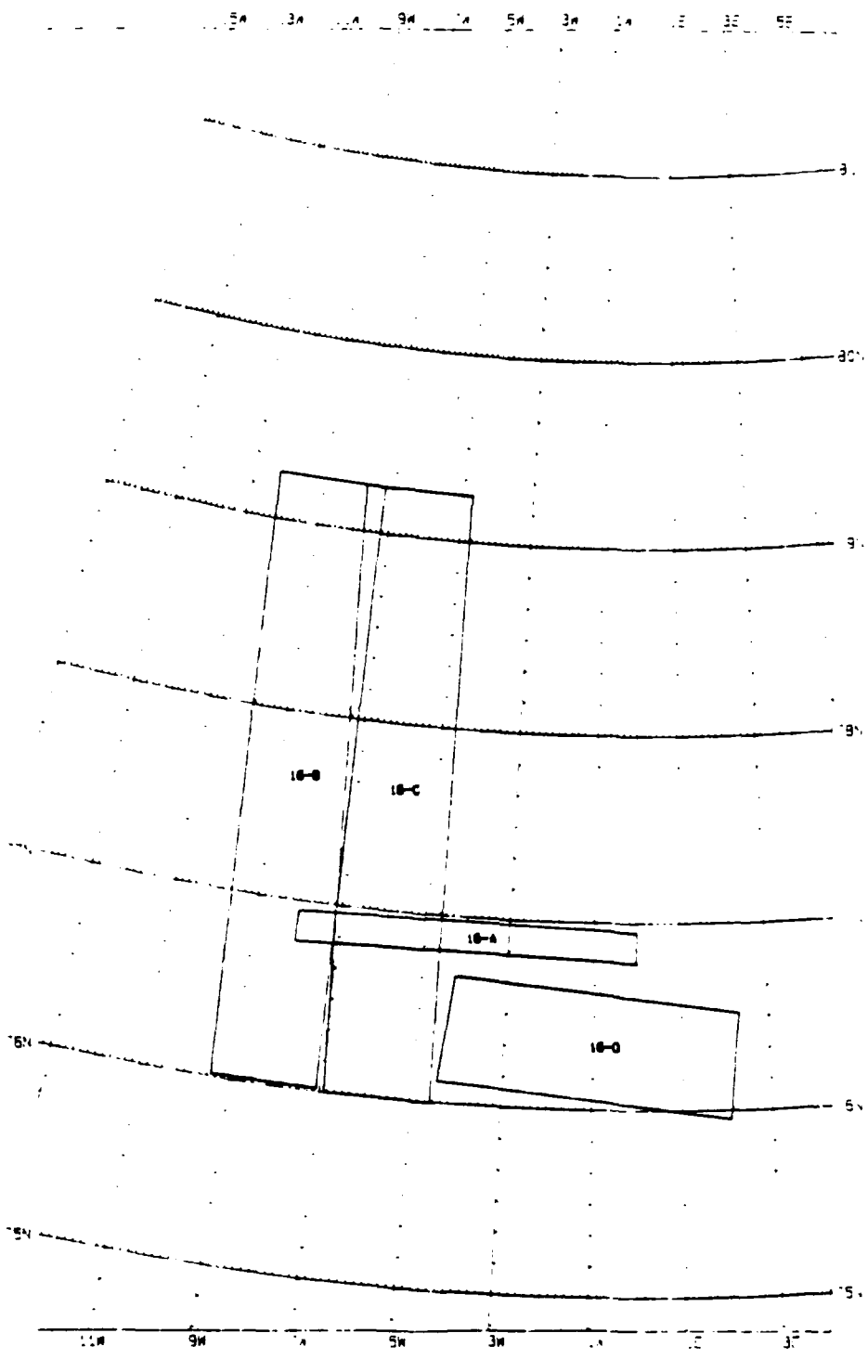


Figure 57. Area of SAR Coverage for MIZEX Mission 16, 7 April 1987

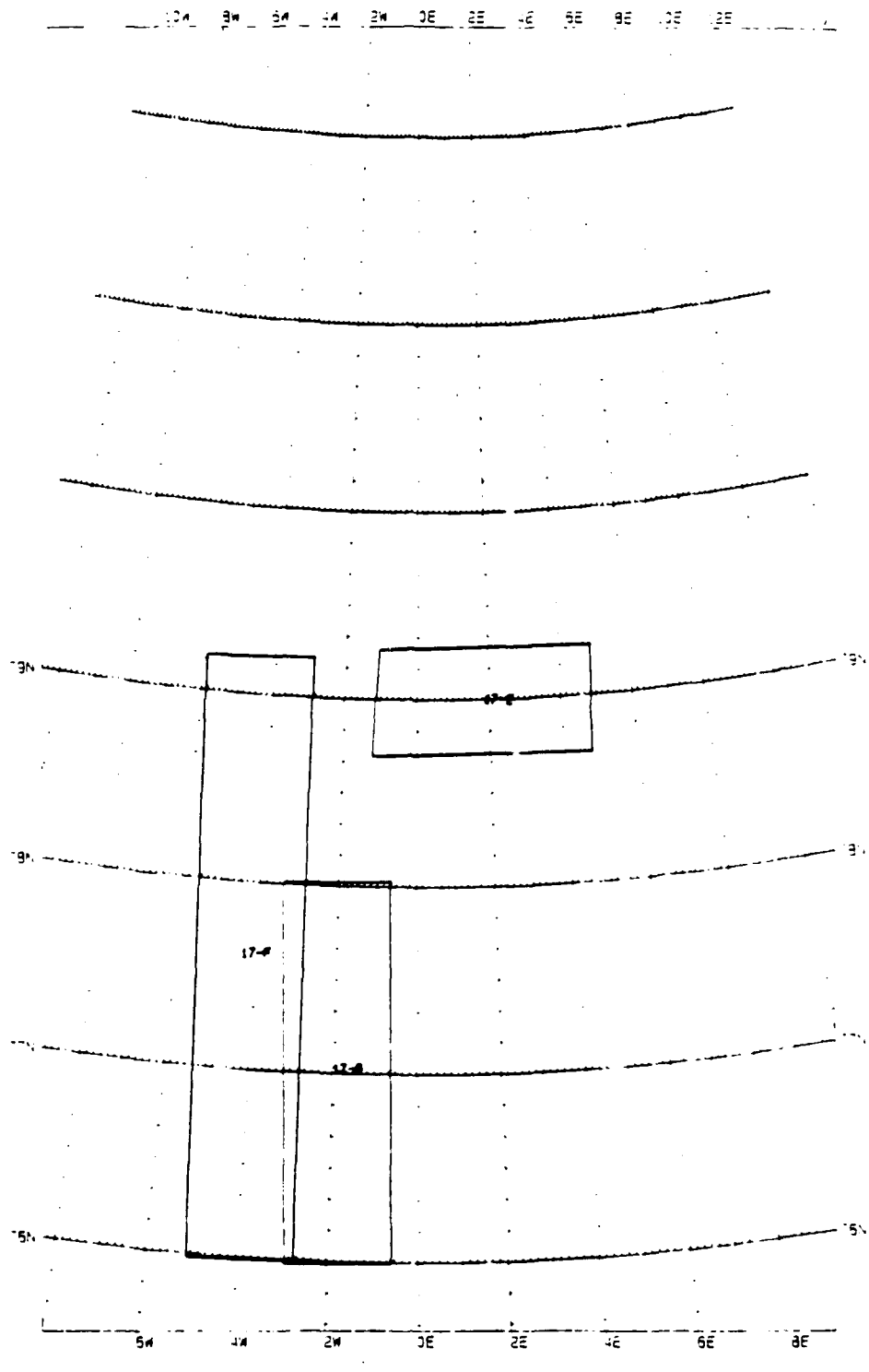


Figure 58. Area of SAR Coverage for MIZEX Mission 17, 7 April 1987

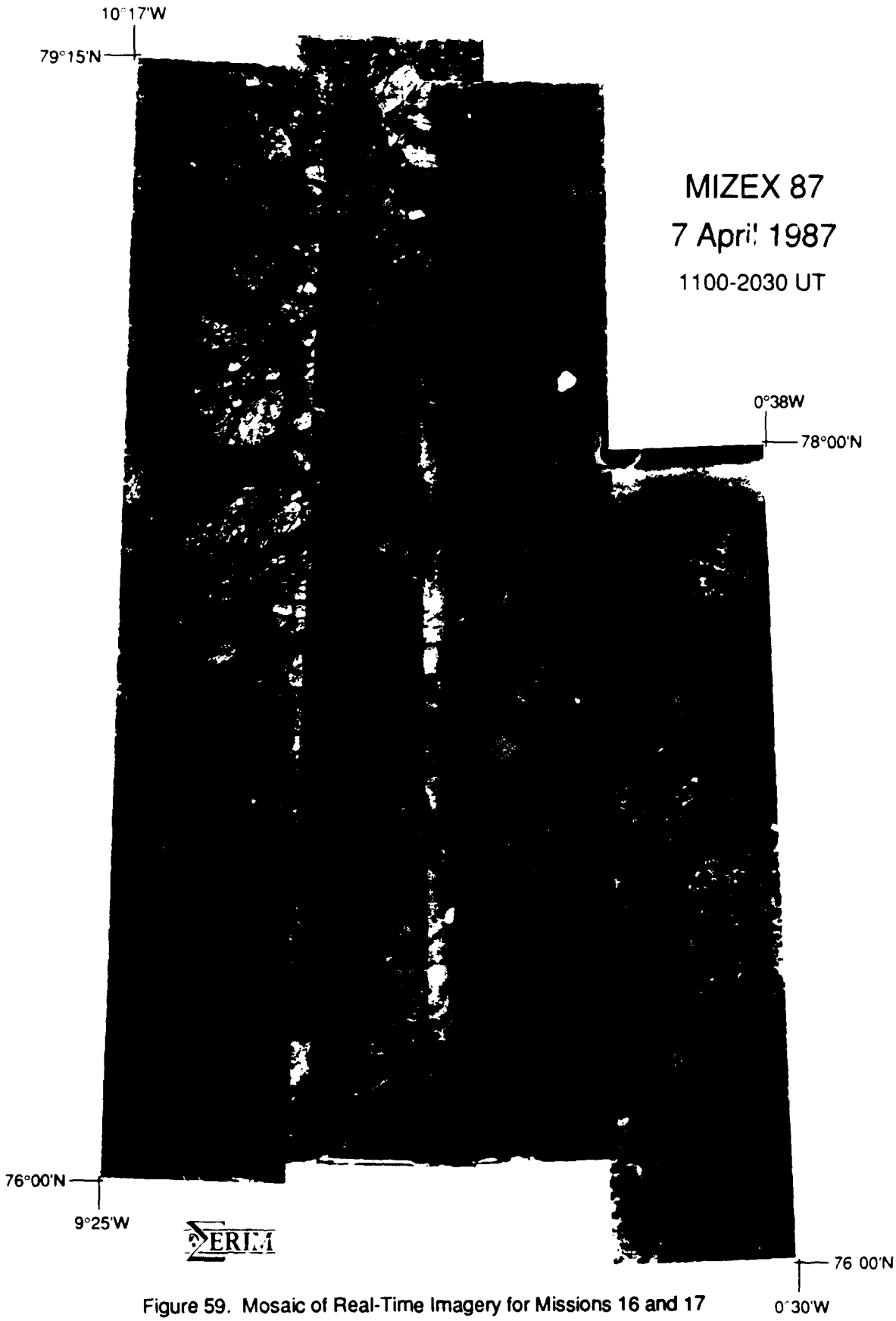


Figure 59. Mosaic of Real-Time Imagery for Missions 16 and 17

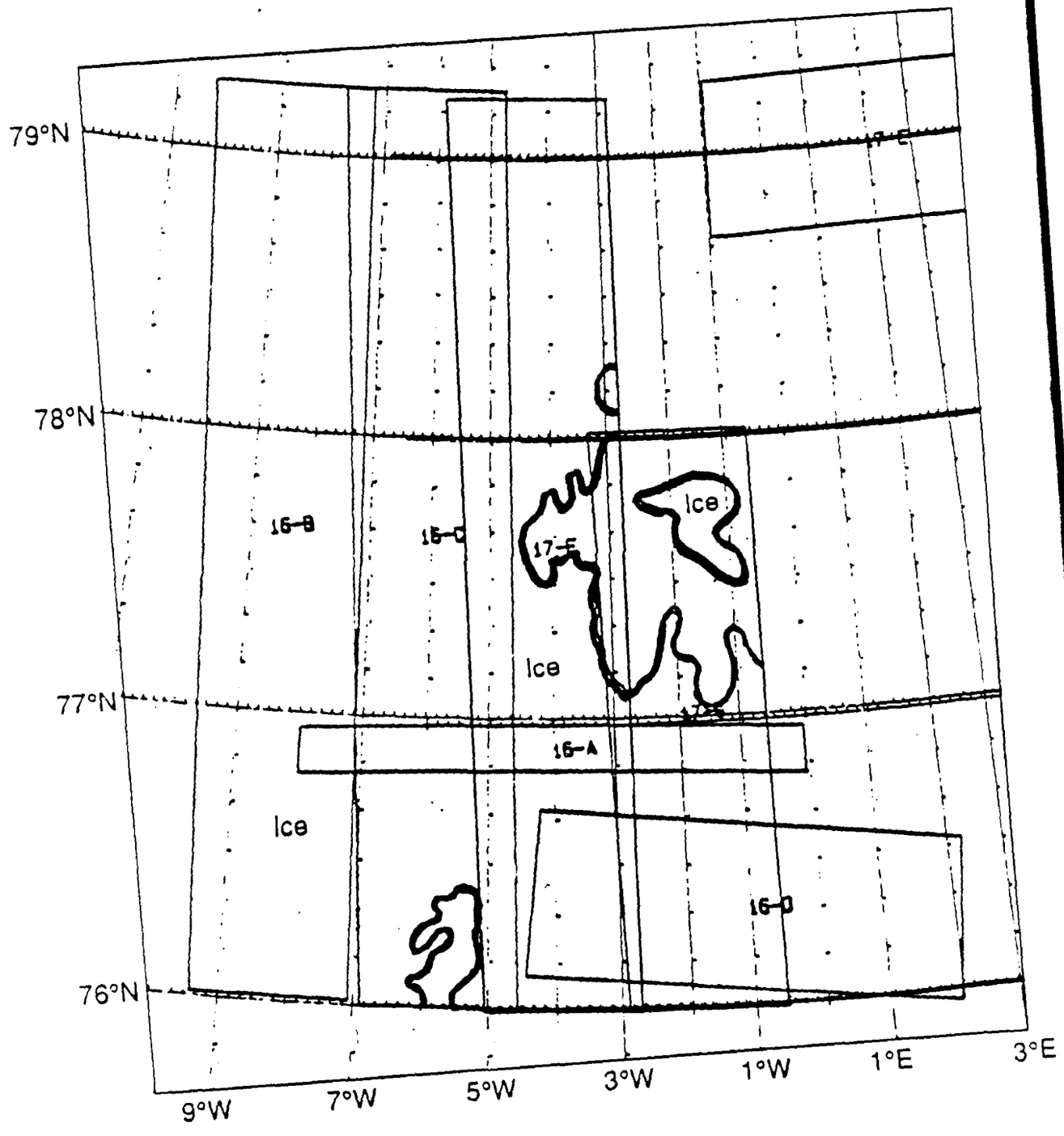


Figure 60. Ice Edge Location for 7 April 1987, Missions 16 and 17

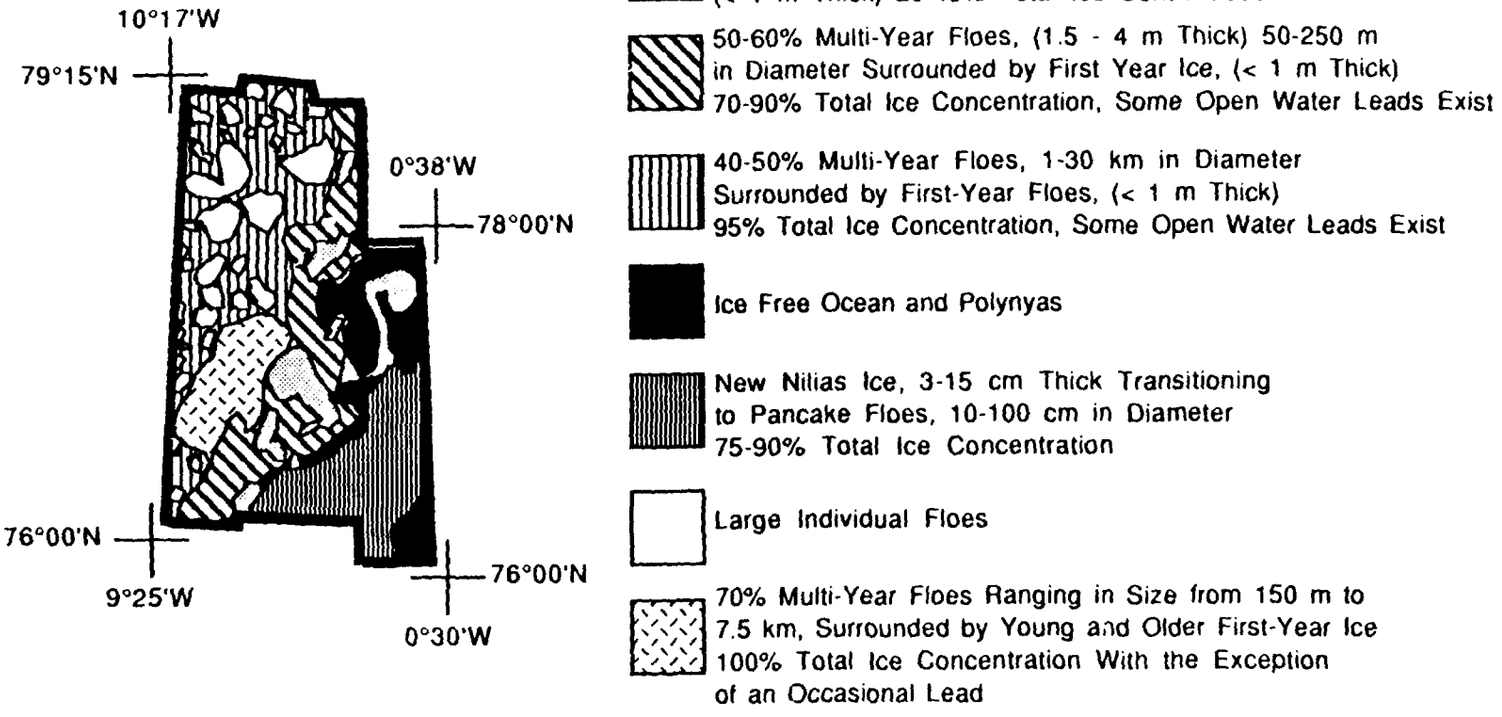


Figure 61. Ice Concentration and Floe Size Interpretation for Mission 16 and 17

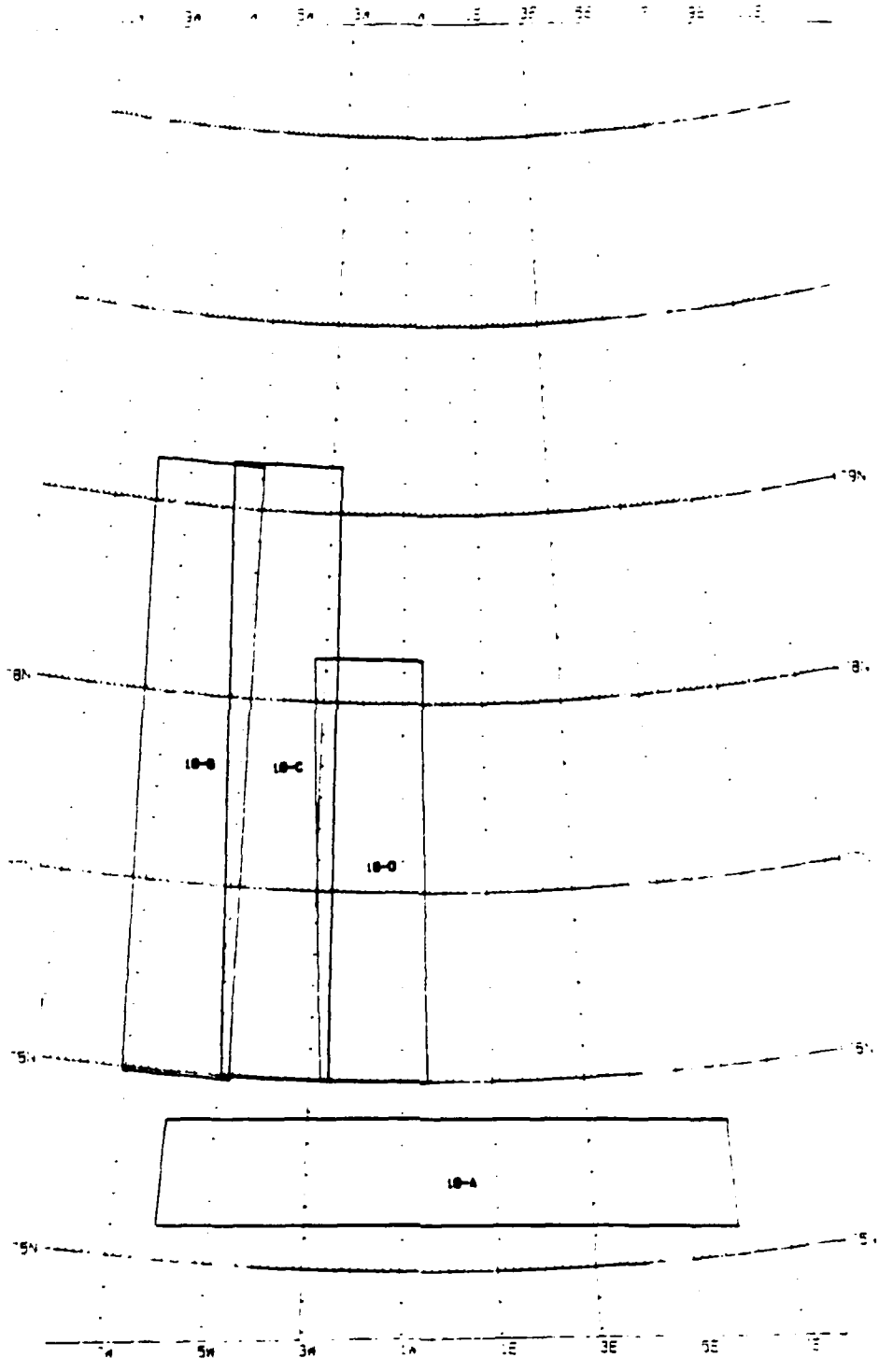


Figure 62. Area of SAR Coverage for MIZEX Mission 18, 8 April 1987

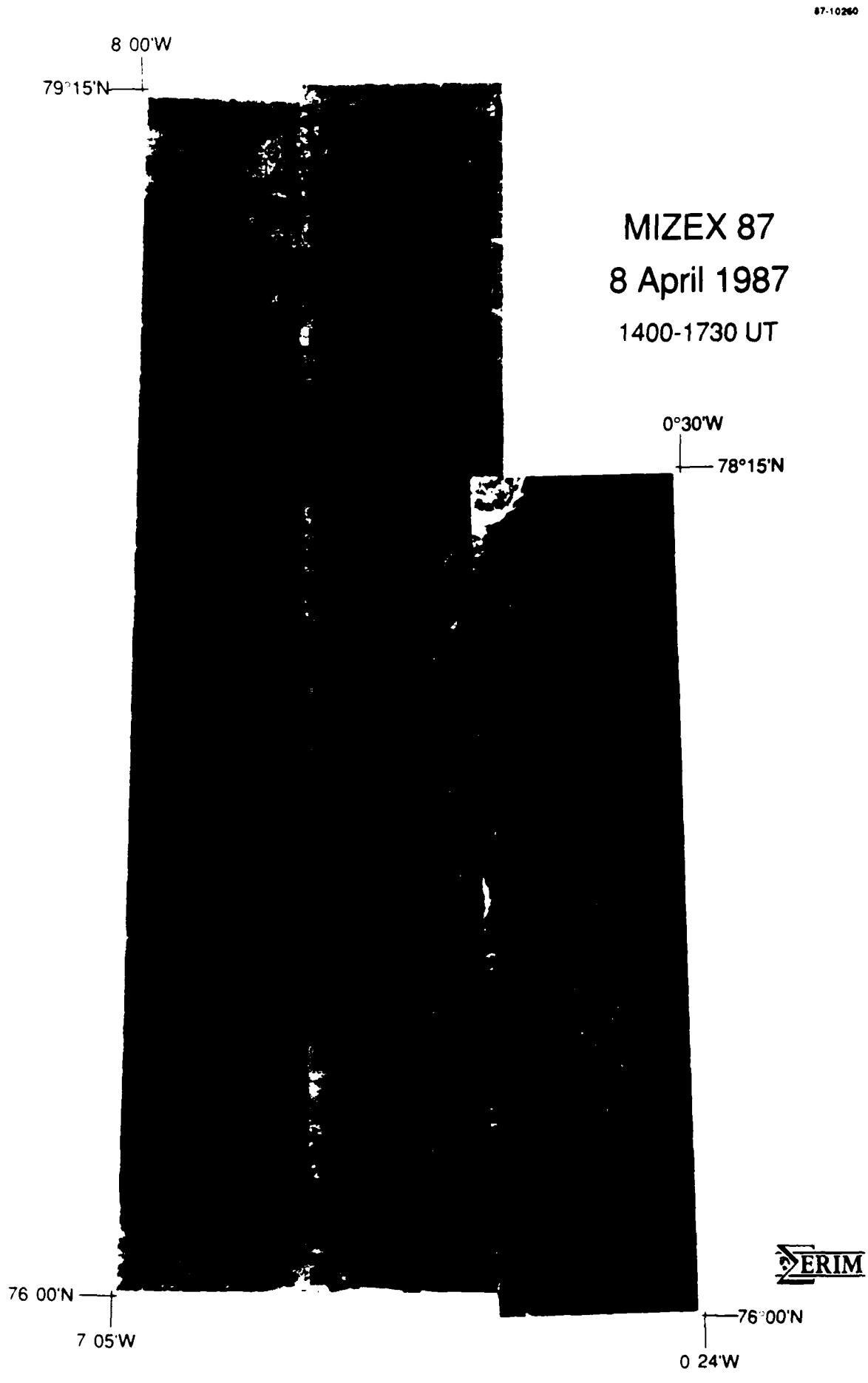


Figure 63. Mosaic of Real-Time Imagery for Mission 18

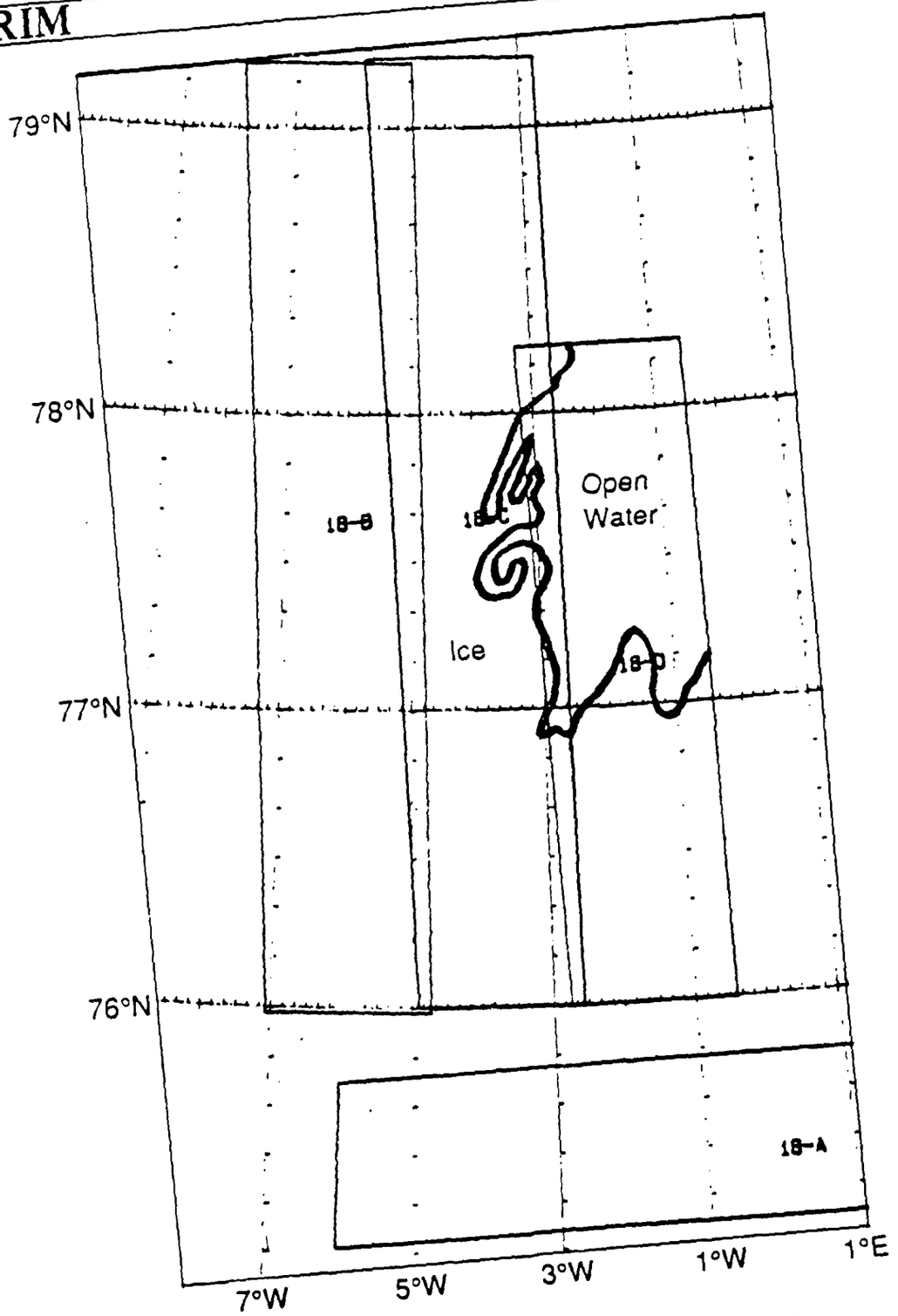
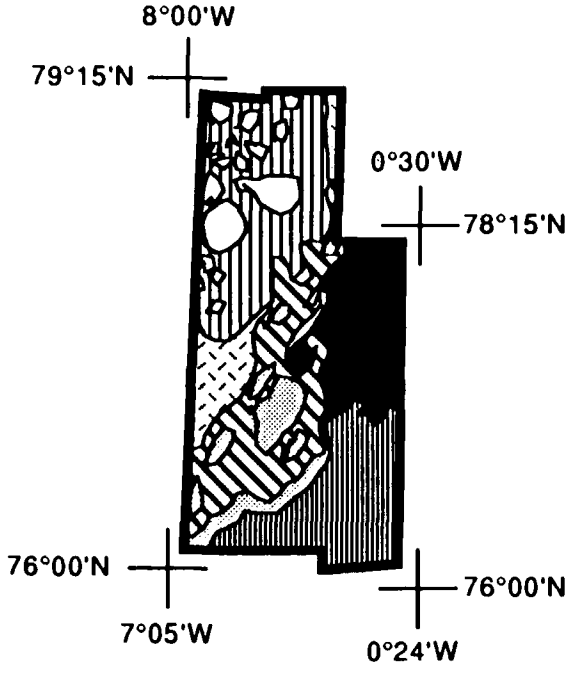


Figure 64. Ice Edge Location for 8 April 1987, Mission 18



50% Multi-Year Fragments, (1.5 - 3.5 m Thick), 50-250 m in Diameter in a First Year Ice Framework, (< 1 m Thick) 20-45% Total Ice Concentration

50-60% Multi-Year Floes, (1.5 - 4 m Thick) 50-250 m in Diameter Surrounded by First Year Ice, (< 1 m Thick) 70-90% Total Ice Concentration, Some Open Water Leads Exist

40-50% Multi-Year Floes, 1-30 km in Diameter Surrounded by First-Year Floes, (< 1 m Thick) 95% Total Ice Concentration, Some Open Water Leads Exist

Ice Free Ocean and Polynyas

New Nilias Ice, 3-15 cm Thick Transitioning to Pancake Floes, 10-100 cm in Diameter 75-90% Total Ice Concentration

Large Individual Floes

70% Multi-Year Floes Ranging in Size from 150 m to 7.5 km, Surrounded by Young and Older First-Year Ice 100% Total Ice Concentration With the Exception of an Occasional Lead

Figure 65. Ice Concentration and Floe Size Interpretation for Mission 18

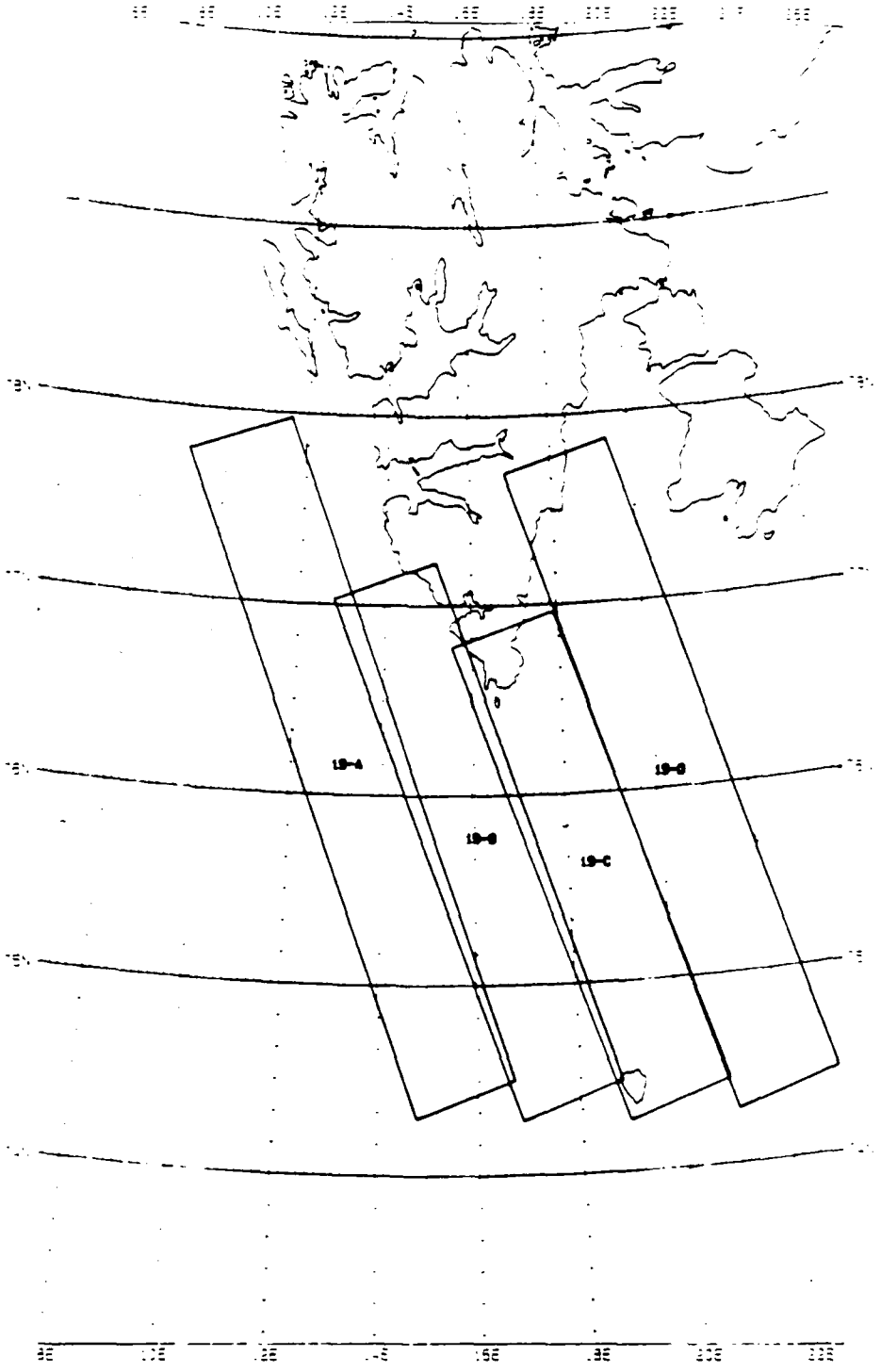


Figure 66. Area of SAR Coverage for MIZEX Mission 19, 9 April 1987

Figure 67. Mosaic of Real-Time Imagery for Mission 19

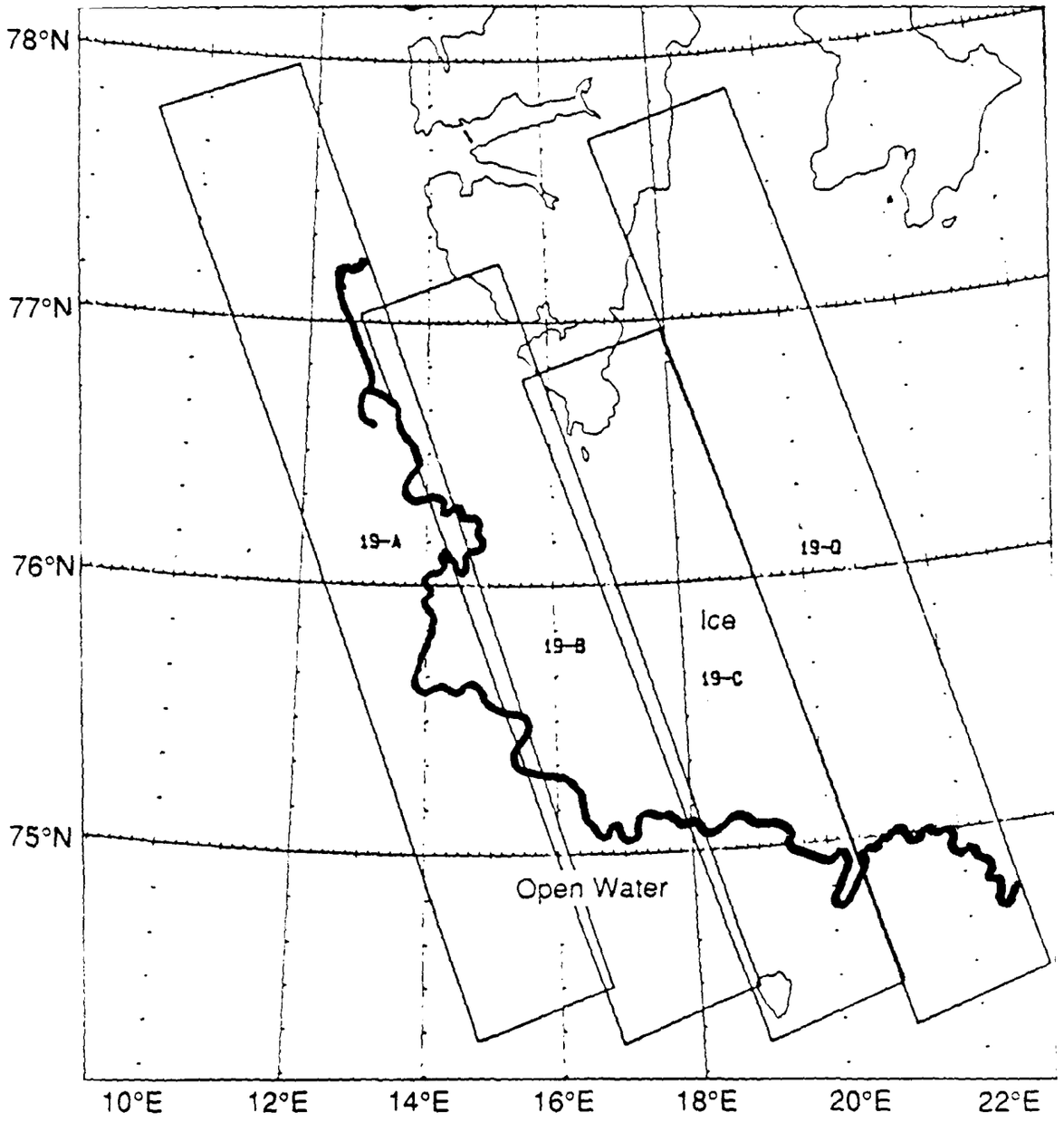


Figure 68. Ice Edge Location for 9 April 1987, Mission 19

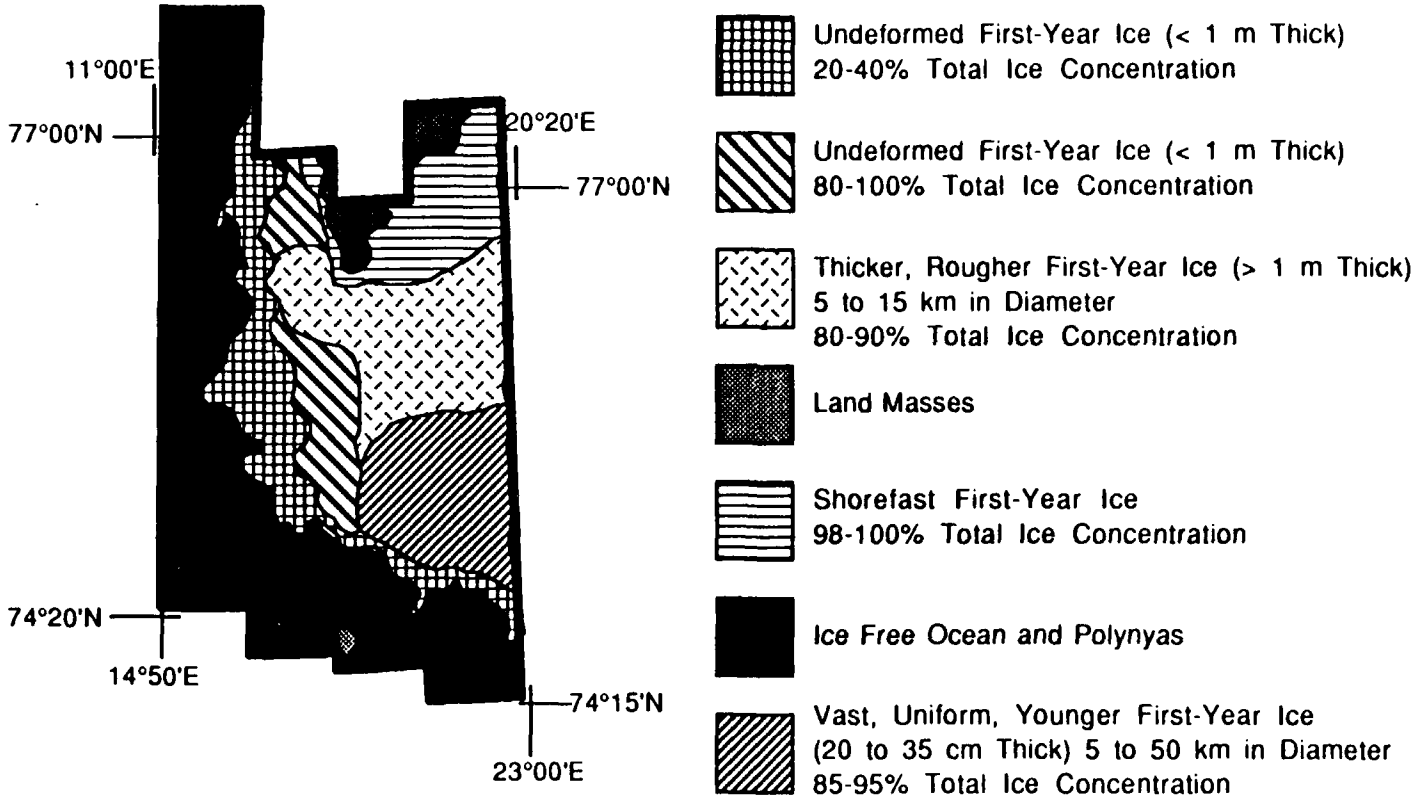


Figure 69. Ice Concentration and Floe Size Interpretation for Mission 19

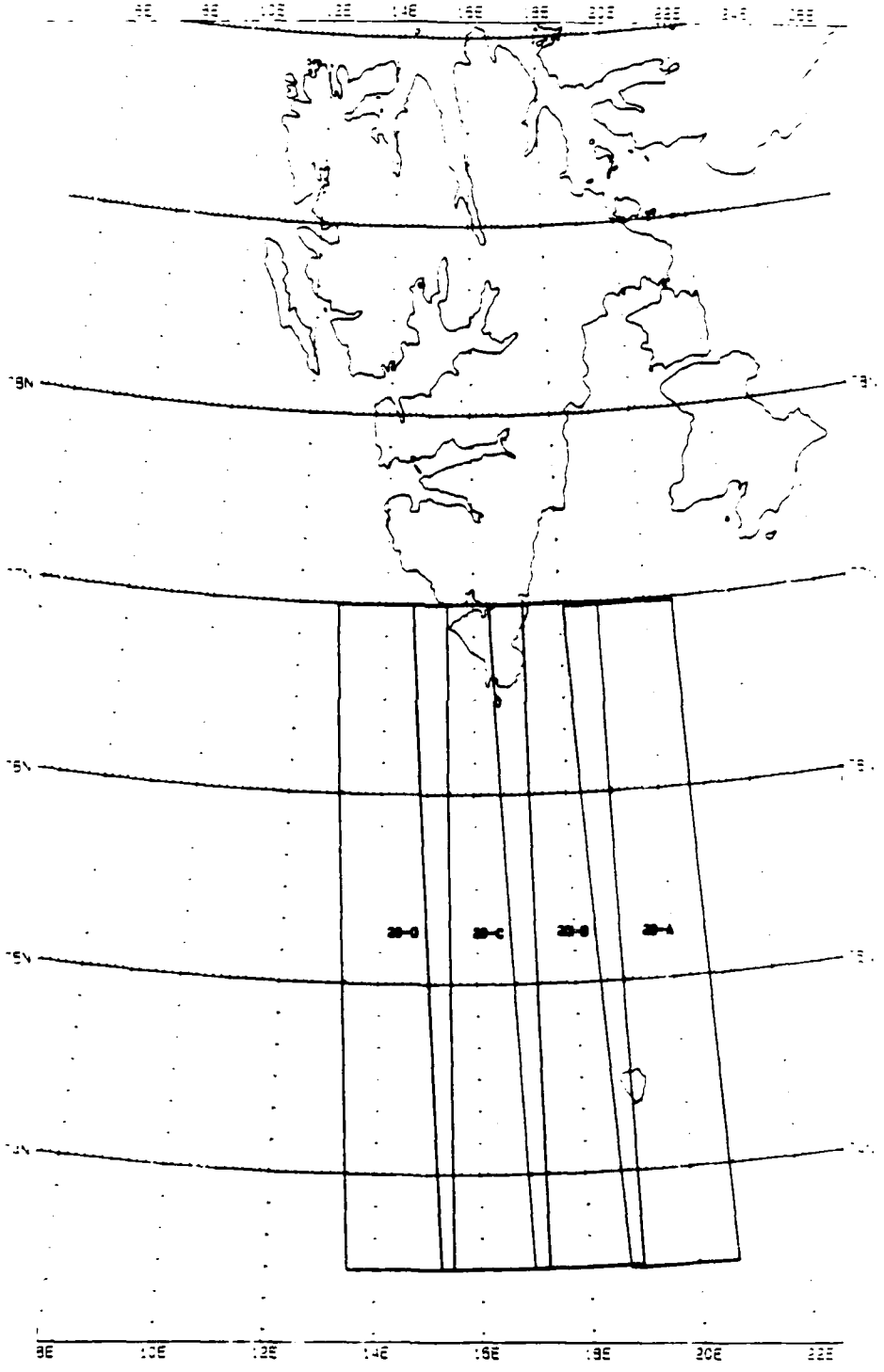


Figure 70. Area of SAR Coverage for MIZEX Mission 20, 10 April 1987

87-10427

MIZEX 87
10 April 1987

0900-1300 UT

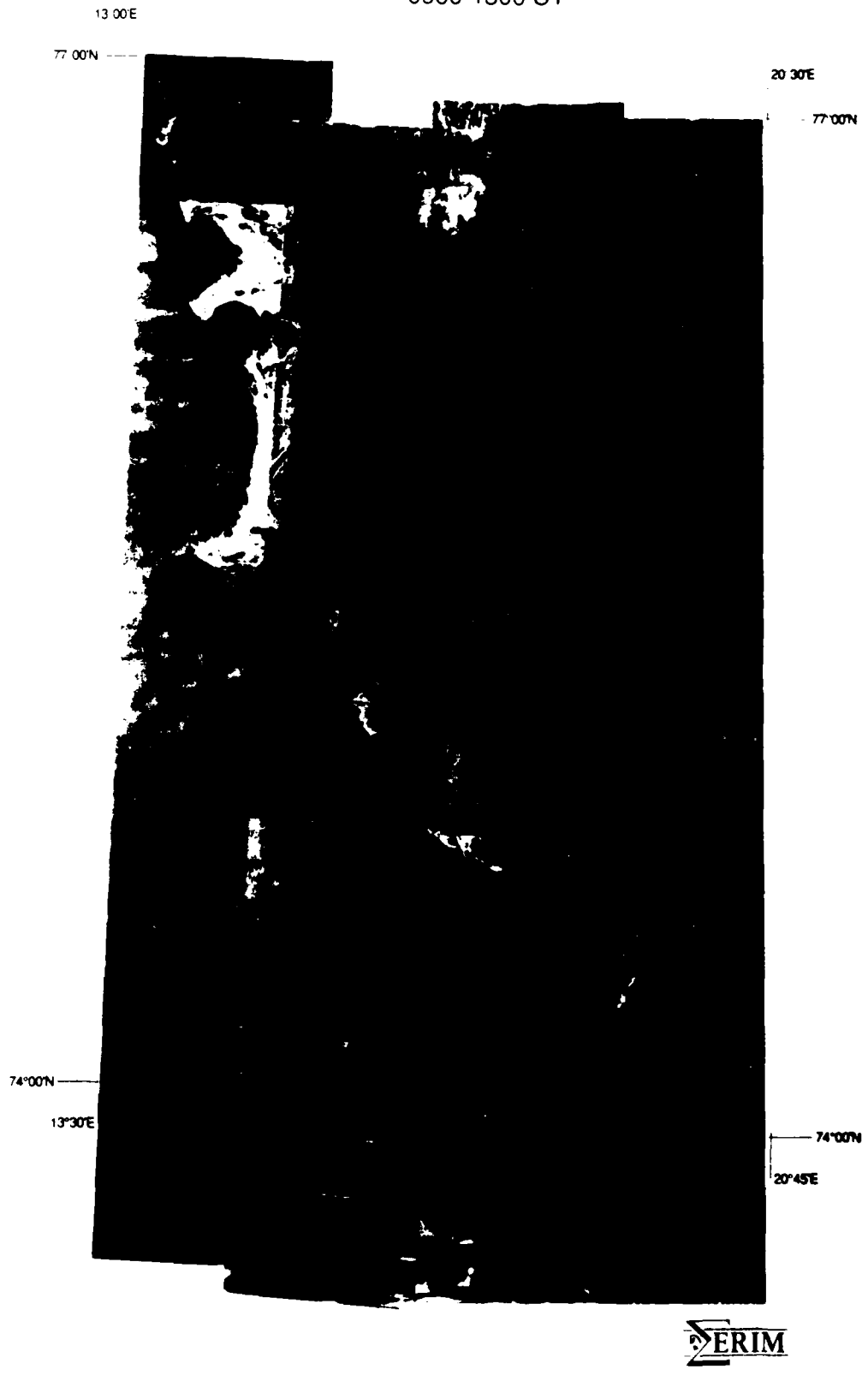


Figure 71. Mosaic of Real-Time Imagery for Mission 20

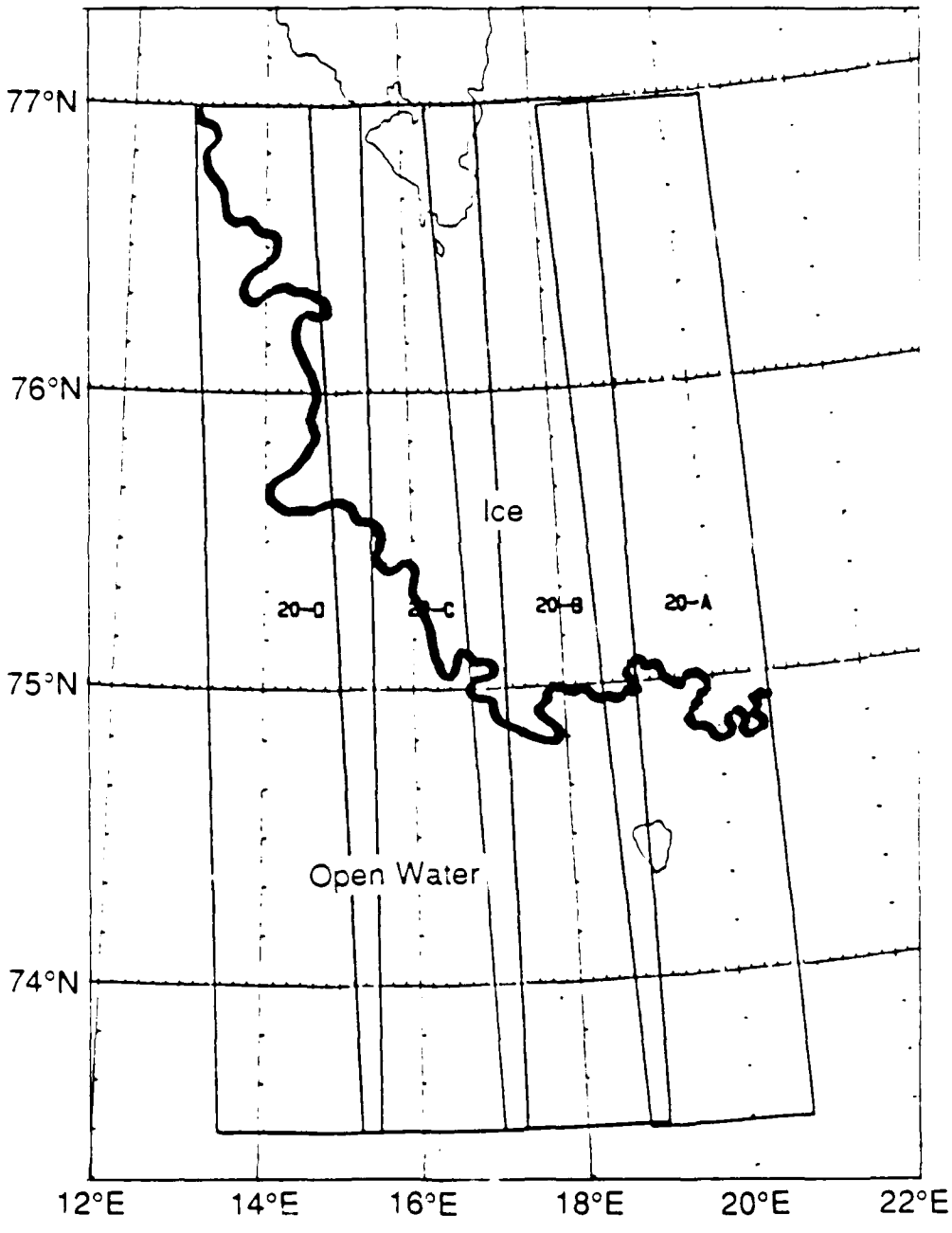


Figure 72. Ice Edge Location for 10 April 987, Mission 20

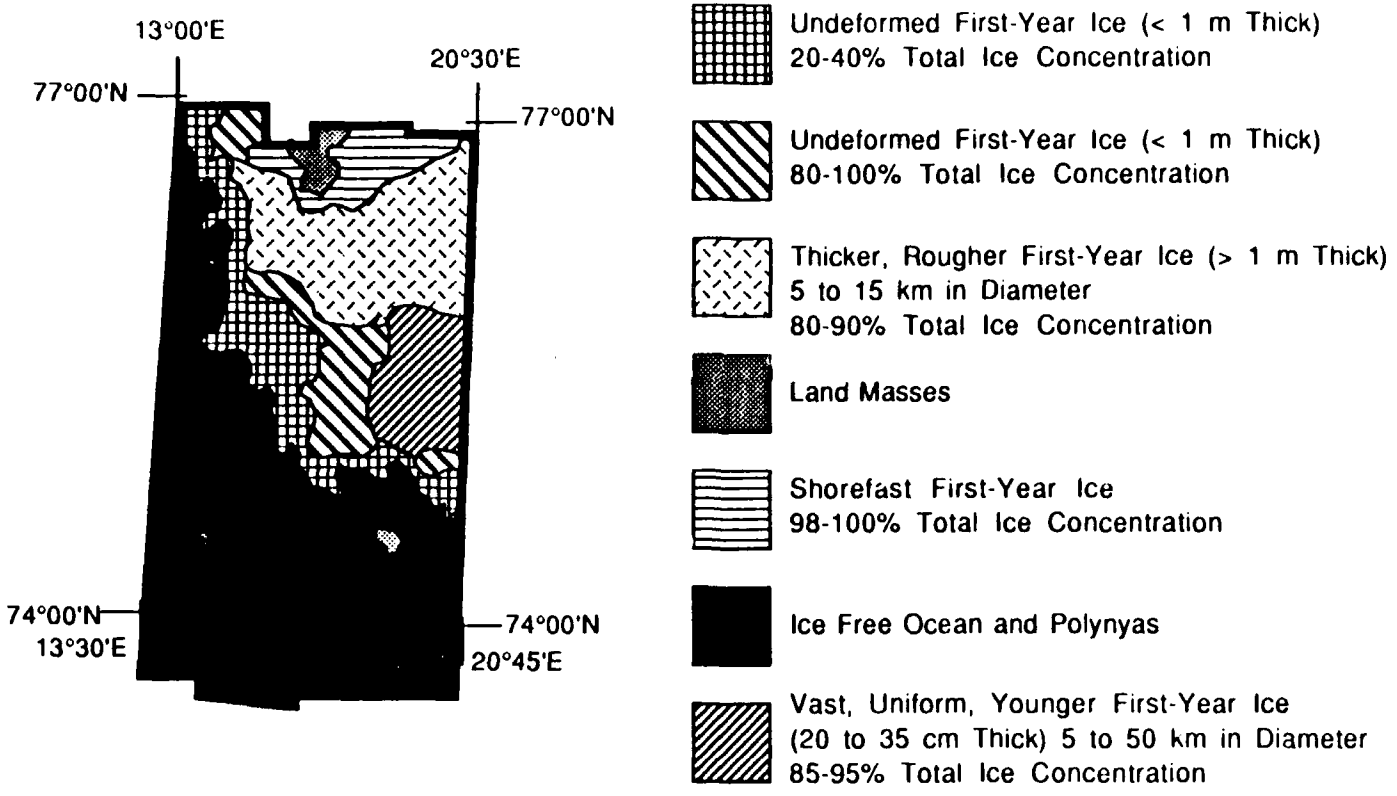


Figure 73. Ice Concentration and Floe Size Interpretation for Mission 20

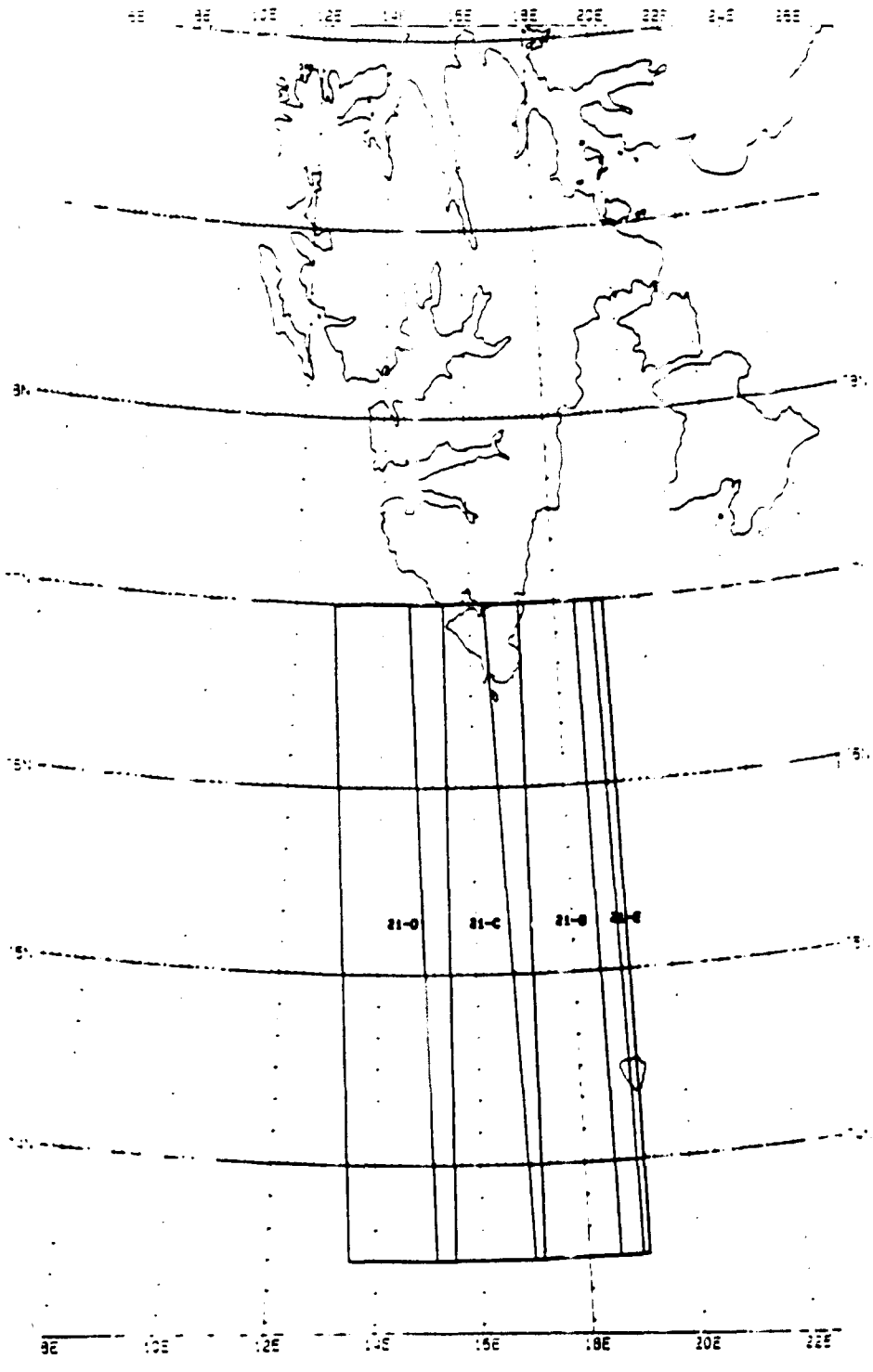


Figure 74. Area of SAR Coverage for MIZEX Mission 21, 11 Apr 1987

MIZEX 87
11 April 1987

0900-1300 UT

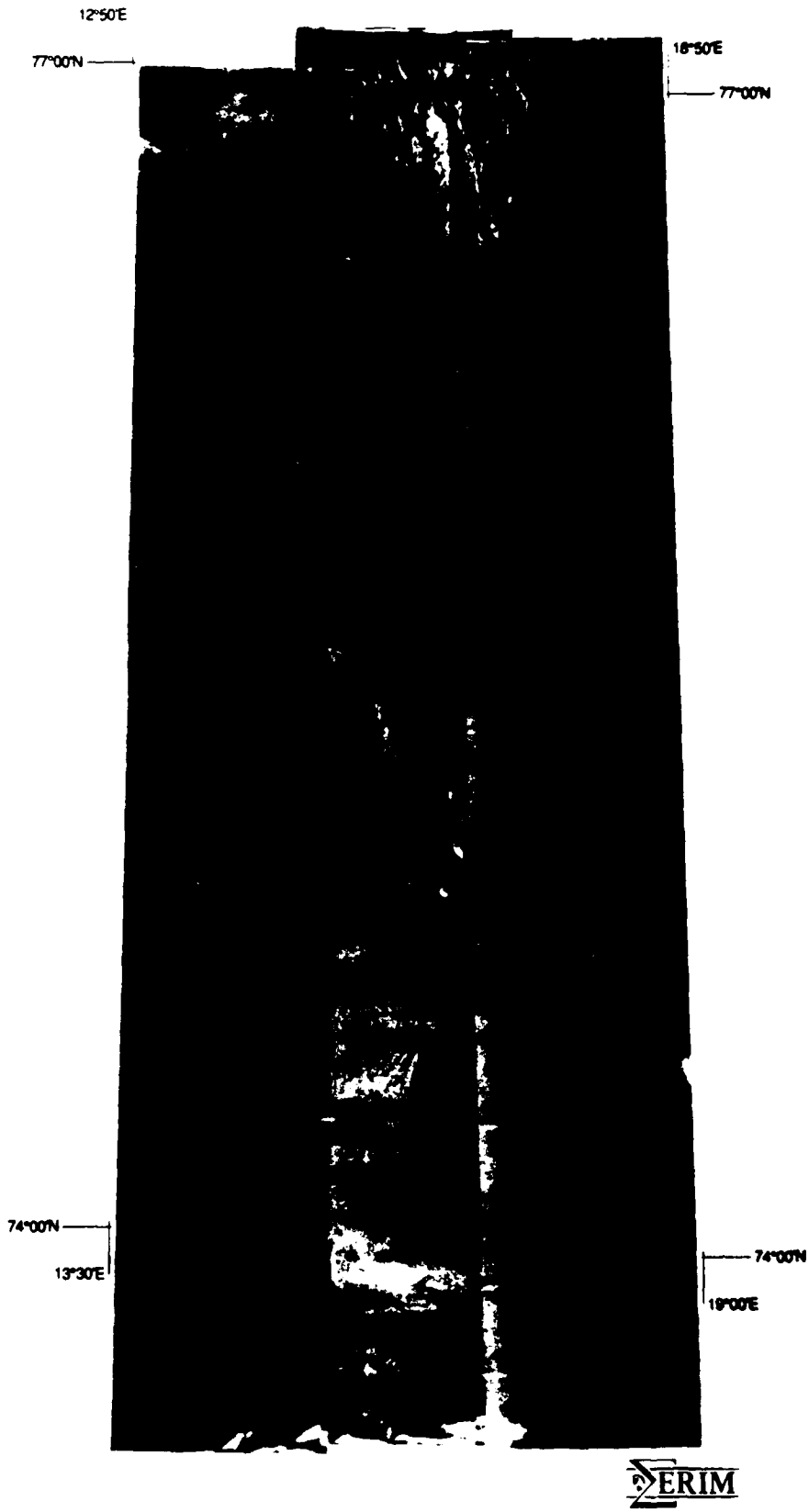


Figure 75. Mosaic of Real-Time Imagery for Mission 21

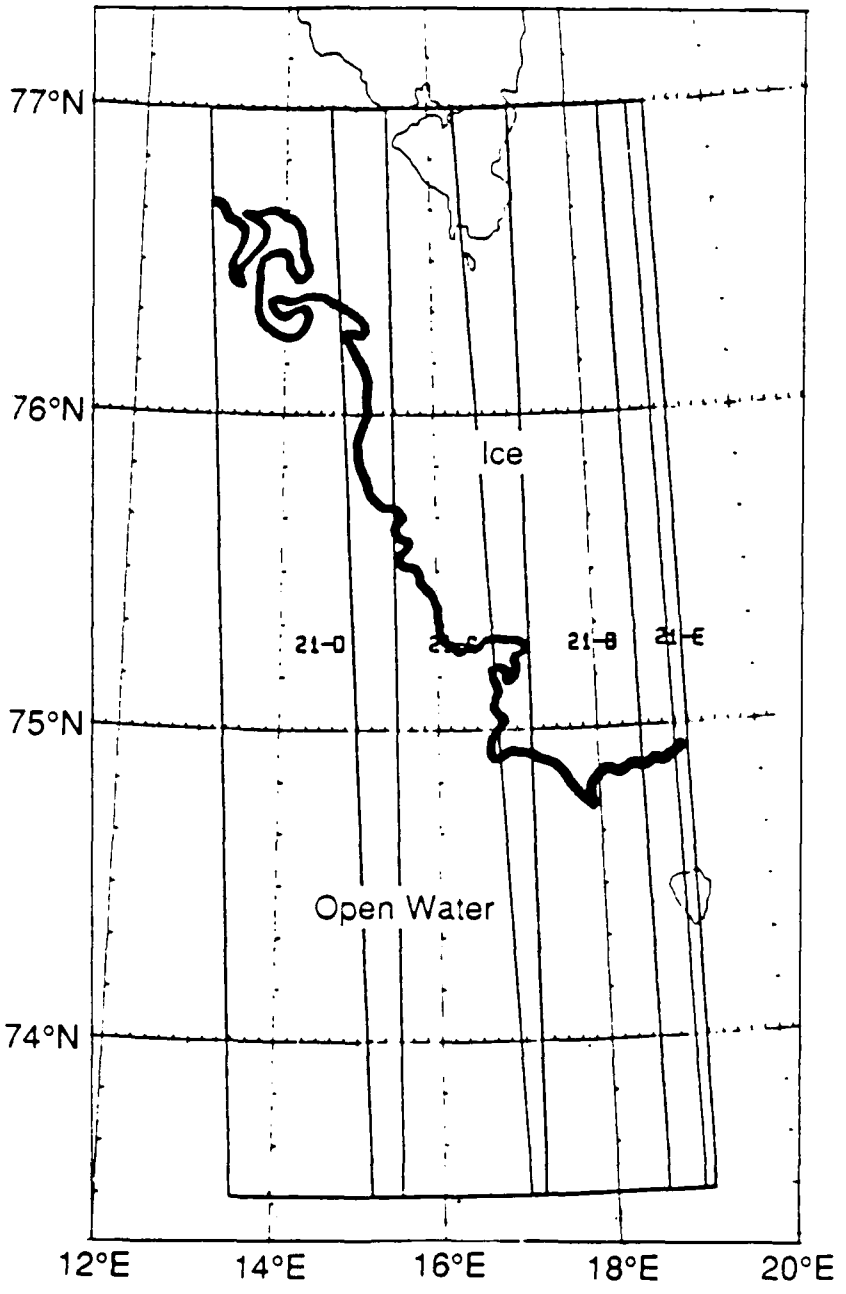
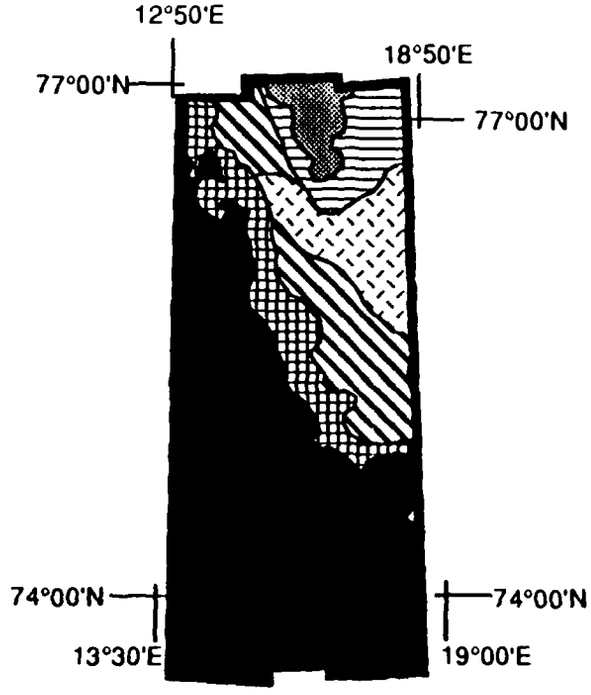


Figure 76. Ice Edge Location for 11 April 1987, Mission 21



Undeformed First-Year Ice (< 1 m Thick)
20-40% Total Ice Concentration

Undeformed First-Year Ice (< 1 m Thick)
80-100% Total Ice Concentration

Thicker, Rougher First-Year Ice (> 1 m Thick)
5 to 15 km in Diameter
80-90% Total Ice Concentration

Land Masses

Shorefast First-Year Ice
98-100% Total Ice Concentration

Ice Free Ocean and Polynyas

Vast, Uniform, Younger First-Year Ice
(20 to 35 cm Thick) 5 to 50 km in Diameter
85-95% Total Ice Concentration

Figure 77. Ice Concentration and Floe Size Interpretation for Mission 21

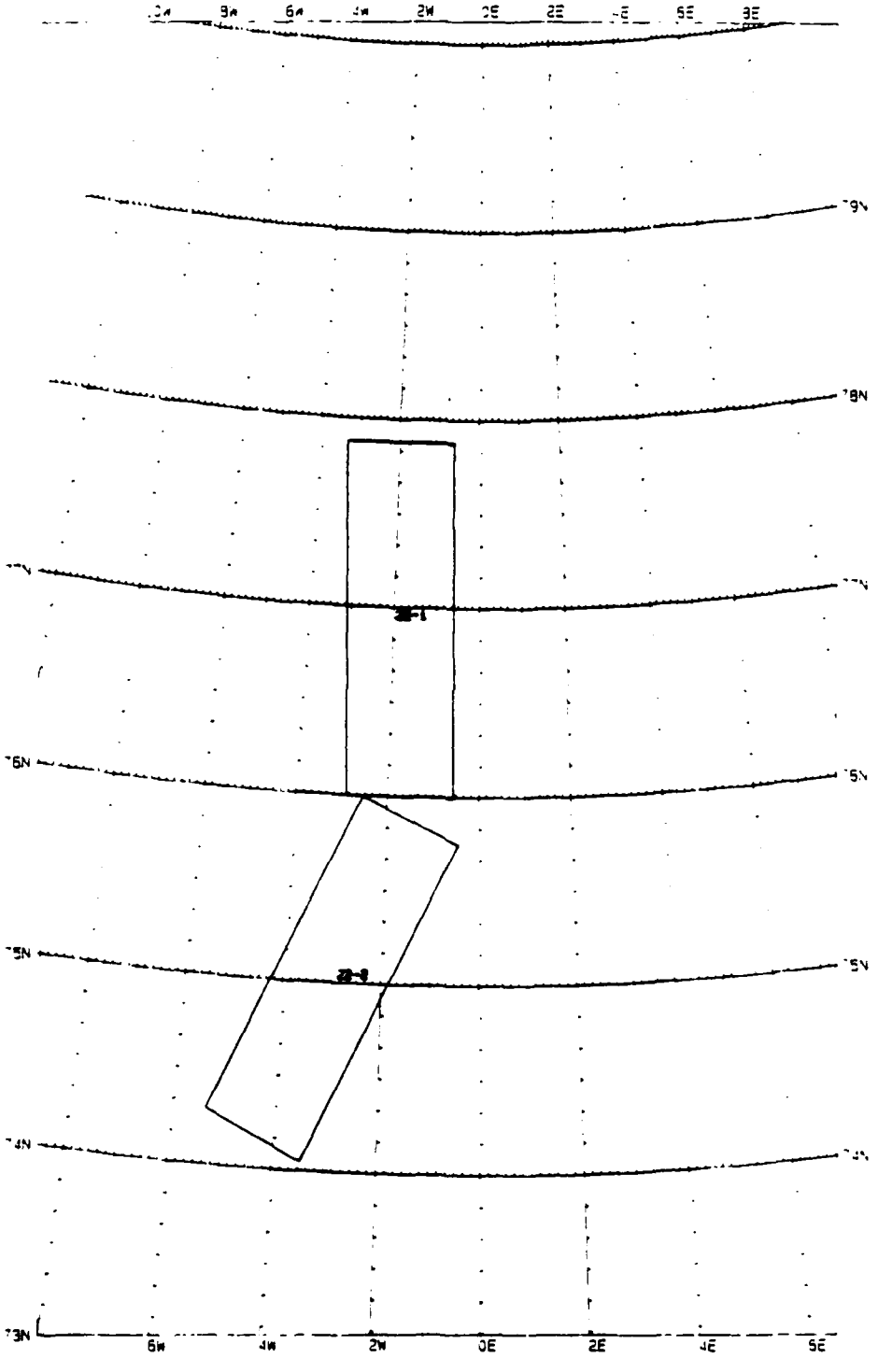


Figure 78. Area of SAR Coverage for MIZEX Mission 22, 12 April 1987

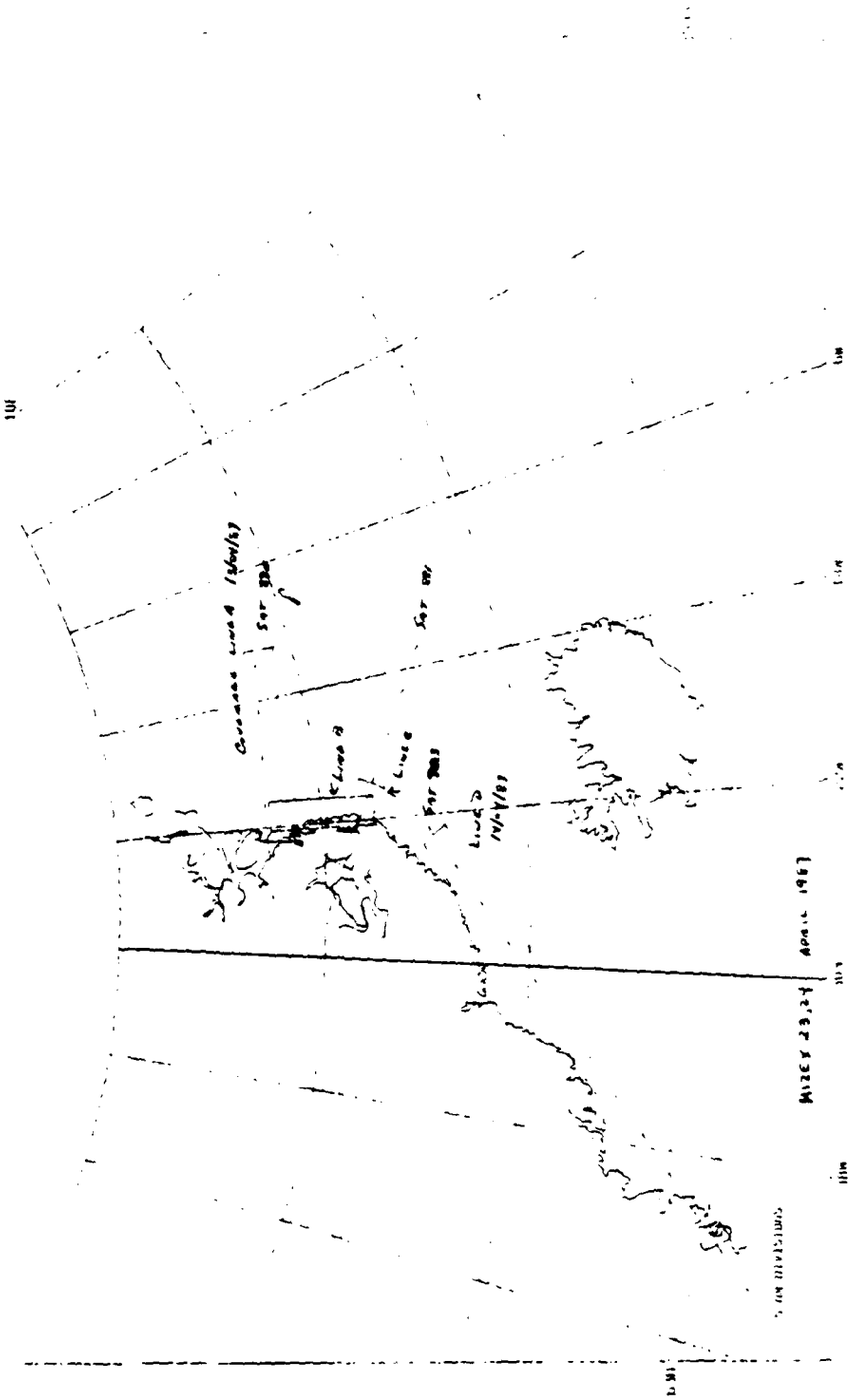


Figure 79. Area of SAR Coverage for NORDA Missions ND-1 and ND-2

5.0 DATA ARCHIVING

As in MIZEX '84, STAR-1 and -2 SAR imagery, scatterometer data, and aerial photography will be made available through the National Snow and Ice Data Center (NSIDC) in Boulder.

All SAR data collected during MIZEX 87 will also be archived at ERIM where copies of detailed mission log sheets are kept on file for data users. Photographic prints of selected areas of the SAR imagery will be available for distribution. Data will be filed by date, mission number, line number and time.

Digitally recorded data includes CCT's of all phase histories. These are referenced by mission number and line number. The images on tapes with the same mission and line number overlap. The overlap is 900 pixels or 400 records. There is no definite overlap between images of the same mission and different line numbers.

Each CCT record is 4096 bytes long. Each byte contains 8 bit data (unsigned byte). Annotation exists for STAR-2 missions (8-22) at the beginning of each line and in some cases at the end of the line. This is written over the entire 4096 elements and is written right into the image. Appendix A contains a log of all CCT's.

Requests for data or prints and related inquiries should be addressed to:

Laura L. Sutherland
Assistant in Research
Radar Science Laboratory
Environmental Research Institute of Michigan
P.O. Box 8618
Ann Arbor, Michigan 48107
Phone: (313) 994-1200 Ext. 2601

APPENDIX A

MIZEX '87 COMPUTER COMPATIBLE TAPE LOG

APPENDIX A: MIZEX '87 CCT LOG

MISSION	DATE FLOWN	LINE	CCT NUMBER
1	27 MAR 87	3	4453
1	27 MAR 87	4	4460
2	28 MAR 87	1	4457
2	28 MAR 87	2	4458
2	28 MAR 87	2A	4450
2	28 MAR 87	3	4459
3	29 MAR 87	1	4454
3	29 MAR 87	2	4451
3	29 MAR 87	3	4452
3	29 MAR 87	4	4461
3	29 MAR 87	5	4462
4	30 MAR 87	B	4450
4	30 MAR 87	C	4463
4	30 MAR 87	D	4664
4	30 MAR 87	E	4665
4	30 MAR 87	F	4666
5	31 MAR 87	A	4667
5	31 MAR 87	B	4668
5	31 MAR 87	C	4669
5	31 MAR 87	D	4670
5	31 MAR 87	E	4671
6	31 MAR 87	A	4672
6	31 MAR 87	B	4455
6	31 MAR 87	C	4706
7	1 APR 87	A	4720
7	1 APR 87	D	4721
7	1 APR 87	G	4722
7	1 APR 87	C2	4723
7	1 APR 87	A	4718
8	2 APR 87	A	3954
8	2 APR 87	A	3953
8	2 APR 87	A	3950
8	2 APR 87	B	3961
8	2 APR 87	B	3469
8	2 APR 87	B	3471
8	2 APR 87	C	3473
8	2 APR 87	C	3478
8	2 APR 87	C	3479
8	2 APR 87	D	3481
8	2 APR 87	D	3482
8	2 APR 87	D	3484
9	2 APR 87	A	3483
9	2 APR 87	C	3487

MISSION	DATE FLOWN	LINE	CCT NUMBER
9	2 APR 87	C	3962
9	2 APR 87	C	3963
9	2 APR 87	E	3964
10	3 APR 87	A	3965
10	3 APR 87	B	3966
10	3 APR 87	C	3967
10	3 APR 87	D	3968
11	3 APR 87	B	3775
11	3 APR 87	C	3802
11	3 APR 87	D	4212
12	4 APR 87	A	3969
12	4 APR 87	A	3970
12	4 APR 87	B	3971
12	4 APR 87	B	3972
12	4 APR 87	B	3973
12	4 APR 87	B	3974
12	4 APR 87	C	3975
12	4 APR 87	C	3976
12	4 APR 87	C	3977
12	4 APR 87	C	3978
12	4 APR 87	D	3979
12	4 APR 87	D	3980
12	4 APR 87	D	3981
12	4 APR 87	D	3982
13	5 APR 87	A	3999
13	5 APR 87	A	4000
13	5 APR 87	A	4001
13	5 APR 87	B	4002
13	5 APR 87	B	4003
13	5 APR 87	B	4004
13	5 APR 87	C	4005
13	5 APR 87	C	4006
13	5 APR 87	C	4007
13	5 APR 87	D	4008
14	5 APR 87	A	3983
14	5 APR 87	A	3984
14	5 APR 87	A	3985
14	5 APR 87	B	3986
14	5 APR 87	B	3987
14	5 APR 87	B	3992
14	5 APR 87	C	3993
14	5 APR 87	D	3994
14	5 APR 87	D	3995
14	5 APR 87	E	3996
14	5 APR 87	E	3997
14	5 APR 87	E	3998
15	6 APR 87	A	4009
15	6 APR 87	A	4010

MISSION	DATE FLOWN	LINE	CCT NUMBER
15	6 APR 87	B	4012
15	6 APR 87	C	4013
15	6 APR 87	C	4014
15	6 APR 87	D	4015
15	6 APR 87	E	4016
15	6 APR 87	E	4020
15	6 APR 87	E	4021
16	7 APR 87	A	4022
16	7 APR 87	A	4023
16	7 APR 87	B	4024
16	7 APR 87	B	4025
16	7 APR 87	B	4026
16	7 APR 87	C	4027
16	7 APR 87	C	4028
16	7 APR 87	C	4029
16	7 APR 87	D	4030
16	7 APR 87	D	4031
17	7 APR 87	E	4036
17	7 APR 87	F	4037
17	7 APR 87	F	4038
17	7 APR 87	F	4039
18	8 APR 87	A	4040
18	8 APR 87	A	4044
18	8 APR 87	A	4045
18	8 APR 87	B	4046
18	8 APR 87	B	4047
18	8 APR 87	B	4048
18	8 APR 87	C	4049
18	8 APR 87	C	4060
18	8 APR 87	C	4061
18	8 APR 87	D	4062
18	8 APR 87	D	4063
19	9 APR 87	A	3843
19	9 APR 87	A	3844
19	9 APR 87	A	3845
19	9 APR 87	A/B	3846
19	9 APR 87	B	3847
19	9 APR 87	B	3848
19	9 APR 87	C	3849
19	9 APR 87	C	3850
19	9 APR 87	C/D	3851
19	9 APR 87	D	3852
19	9 APR 87	D	3853
19	9 APR 87	D	3854
20	10 APR 87	A	3855
20	10 APR 87	A	3856
20	10 APR 87	A	3857

MISSION	DATE FLOWN	LINE	CCT NUMBER
20	10 APR 87	B	3858
20	10 APR 87	B	3859
20	10 APR 87	B	3860
20	10 APR 87	C	3861
20	10 APR 87	C	3868
20	10 APR 87	C	3869
20	10 APR 87	D	3870
20	10 APR 87	D	3871
20	10 APR 87	D	3872
21	11 APR 87	B	3873
21	11 APR 87	B	3874
21	11 APR 87	B	3875
21	11 APR 87	E	3876
21	11 APR 87	E	3877
21	11 APR 87	E	3842
21	11 APR 87	C	3944
21	11 APR 87	C	3945
21	11 APR 87	C	3946
21	11 APR 87	C	3947
21	11 APR 87	D	3948
21	11 APR 87	D	3951
21	11 APR 87	D	3952
22	12 APR 87	1	4032
22	12 APR 87	1	4033
22	12 APR 87	2	4034
22	12 APR 87	2	4035